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CHEMICAL & ENGINEERING NEWS

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CHEMICAL & ENGINEERING NEWS

Volume 64, Number 30
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News of the Week

■ **Earnings of many U.S. chemical companies increased for the second consecutive quarter.** **Page 6**

■ **FDA approves use of human vaccine for hepatitis B that was developed by recombinant DNA techniques.** **Page 7**

■ **Union Carbide will sell its agricultural chemicals division to reduce corporate debt.** **Page 7**

■ **Jean-René Fourtou becomes new chairman of Rhône-Poulenc in French prime minister's drive toward privatization of industry.** **Page 8**

■ **Metal matrix composite materials will be tested in vertical tails of Air Force fighter planes at Lockheed-Georgia facility.** **Page 8**

Cover: Organic chemist carries out drug research at Smith Kline & French Laboratories' new R&D complex in Upper Merion, Pa.

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Special Report

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Chemical Stocks Outperform Other Industrials During Past 12 Months

Index is up almost 50% from a year ago, but has fallen from all-time high seen at beginning of this month

William J. Storck, C&EN New York

Stock market indexes have been setting new records recently. Although the Dow Jones Industrial Average has fallen in the past couple of weeks from its all-time high of 1909, analysts believe it is only a matter of time before it gets rolling again to still higher peaks.

And, not to be outdone, C&EN's chemical stock index itself hit a record high 433 (1957 = 100) at the same time. In the past 12 months, the chemical stock index continued to outperform the Dow Jones average. In the period between July 19, 1985, and July 18 of this year, C&EN's index rose 47% whereas the Dow increased just 31%. In fact, in that time the chemical stock index beat all other major stock market indicators. During the period, the New York Stock Exchange Composite Index climbed 20%, the NYSE Industrials 21%, the American Stock Exchange Index 13%, the Over-the-Counter Composite 24%, the OTC Industrials 20%, and the Standard & Poor's 500 and the S&P 400 Industrials both up 21%.

C&EN's chemical stock index is based on the weighted market value of the stocks of American Cyanamid, Celanese, Dow Chemical, W. R. Grace & Co., Hercules, Monsanto, and Union Carbide.

In all fairness, however, it must be pointed out that the chemical stock index seems to be becoming more volatile than the more broadly based indexes. For instance, while the Dow Jones Industrials fell 6.9% in the past few weeks from its high, the C&EN index dropped 7.9%.

If stock prices are seen to be predictive, the trend bodes well for the chemical industry over the next few months. Many analysts see the chemical industry growing in terms of earnings if not in volume over the next half year as companies continue to get cost breaks on raw materials and as productivity and efficiency programs continue to pay off. Longer term, there is hope that the foreign trade picture will improve as chemicals regain some of their traditional overseas markets lost during the period when the dollar was very strong against other currencies.

Analysts like to point to the declining price of oil and natural gas feedstocks as a case for improved earnings in the next few months. But many caution that at the same time, chemical prices also are falling. The key to improved earnings is that the chemical price not fall so fast and so quickly as the feedstock costs. So far, chemical price declines have lagged drops in raw material costs.

Analysts also point out that most of the major restructuring moves have already taken place and that the shucking off of less than desir-

Chemical stock index outperforms all other indexes

	July 18, 1986	July 18, 1985	% change
Dow Jones Industrial Average	1777.98	1359.54	30.8%
New York Stock Exchange Composite	136.35	113.26	20.4
New York Stock Exchange Industrials	155.36	128.84	20.6
American Stock Exchange Index	267.67	236.84	13.0
Over-the-Counter Composite	381.07	307.76	23.8
Over-the-Counter Industrials	376.14	313.76	19.9
Standard & Poor's 500	236.36	195.13	21.1
Standard & Poor's 400 Industrials	261.47	215.83	21.1
C&EN chemical stock index	399	271	47.2

Chemical stocks have risen faster than major industrials in past year

a C&EN weighted stock price index of American Cyanamid, Celanese, Dow Chemical, W. R. Grace, Hercules, Monsanto, and Union Carbide.

able businesses and plants, the shutdown of outmoded facilities, and the cutting of employees over the past year or more have poised the chemical industry for good earnings leverage in the coming months. Also, with the greater efficiency of the industry, a moderate upward swing in capacity utilization could bring an increase in earnings that would be out of scale with the capacity use increase.

This swing in capacity utilization could easily be brought about by an increase in chemical exports or a decline in imports. With the dollar 25% or more weaker than it was a year ago, U.S. chemicals become much more competitive on world markets. The result could be an increase in exports from the U.S. as domestic companies find it easier to sell abroad. More likely than that in the next few months, according to economists, is that foreign imports into the U.S. will decrease as the declining dollar raises the price of imported chemicals.

The idea of increasing earnings in the next few months is reflected in the price/earnings ratios (price per share of stock divided by earnings per share) of the companies on the list. Although it is said that stock prices indicate the direction of the economy as much as six months into the future, the price/earnings ratio is based on the past 12 month's income. Thus, as the price/earnings ratio moves higher, it indicates that stock buyers think that earnings are going to grow.

Right now the price/earnings ratios for many chemical companies are unusually high. In recent years, stock prices for chemical companies have averaged about 10 to 15 times earnings, but as the value of their stock has moved up in advance of earnings so, of course, have the ratios for individual companies. Thus, a situation currently exists where Dow Chemical stock is selling at 84 times earnings, for example, and International Minerals' stock price is 54 times earnings per share.

Of the companies that make up the index, Celanese's stock has shown the best performance in the past year, rising more than 58%. At least some of that rise, however, must be attributed to the company's stock buy-back program, which has had much of the same effect as a reverse stock split. Following Celanese's stock performance are an annual rise of 51% for Dow Chemical, 41% for Union Carbide, 33% for American Cyanamid, 26% for Hercules, 25% for Monsanto, and 19% for W. R. Grace. Monsanto and Grace have had problems because of their ties to the agricultural chemicals industry.

Not surprisingly, shares of many of these companies are selling near their 12-month highs. American Cyanamid stock is down 8% from its high, Dow about 10%, Union Carbide and Hercules about 11%, Monsanto 12%, and Grace 18%.

On a broader list of 30 chemical firms, only six are selling for less than they were a year ago. For First Mississippi stock, the price is 35% below its year-ago level, for Freeport-McMoRan 23%, for International Minerals 24%, for Ethyl 18%, for Petrolite 15%, and for Reichhold 15%. Three of these companies—First Mississippi, Freeport, and IMC—are tied to agriculture, and Petrolite is in oil field chemicals, both highly troubled industries at present.

Other leaders in gains on the list include Crompton & Knowles, up 44%; Chesebrough-Pond's, up 42%; International Flavors, up 36%; Olin, up 35%; Witco, up 31%; Rohm & Haas, up 30%; Loctite, up 26%; and Lubrizol, up 25%.

Companies other than those on C&EN's chemical stock index that are selling near their highs include Crompton & Knowles, H. B. Fuller, PPG Industries, International Flavors, and Ethyl. □

Most stock prices are up handsomely from a year ago

	Stock price July 18, 1986	% change from year earlier	% change from 12-month high	% change from 12-month low	Price/earnings ratio[a]	Dividend yield, % of price
Air Products	$ 32½	17.1%	−21.9%	26.2%	13	2.5%
American Cyanamid	72½	32.7	−8.2	49.1	26	2.6
Celanese	205	58.3	−13.1	82.2	13	2.4
Chemed	34½	15.0	−13.8	30.8	14	4.5
Chesebrough-Pond's	47	42.4	−10.7	51.6	15	4.1
Crompton & Knowles	33	43.5	−5.4	52.6	14	3.8
Dow Chemical	55	50.7	−9.7	64.2	84	3.3
Essex Chemical	29½	5.8	−20.3	60.5	17	2.3
Ethyl	19½	−18.3	−13.3	85.7	21	1.6
First Mississippi	5⅞	−34.7	−40.5	11.9	9	4.1
Freeport-McMoRan	15½	−23.0	−27.9	8.8	—	10.6
H. B. Fuller	29⅛	4.0	−6.0	100.9	16	1.3
W. R. Grace	49⅝	18.9	−18.3	39.8	23	5.7
Hercules	49¼	26.3	−10.5	43.8	19	3.6
International Flavors	43¼	35.7	−11.5	52.4	22	2.7
International Minerals	32⅝	−24.3	−25.9	9.7	54	3.1
Loctite	40½	26.1	−12.4	39.7	19	2.2
Lubrizol	30	25.0	−14.6	51.9	17	3.9
Monsanto	65¾	24.9	−12.2	61.8	—	3.9
Morton Thiokol	34½	−5.8	−14.8	15.0	13	2.0
Nalco Chemical	25⅜	−2.4	−18.8	15.3	14	4.8
National Distillers	35⅝	4.0	−19.7	19.2	16	6.0
Olin	43⅝	35.3	−18.1	46.0	—	3.4
Pennwalt	49½	22.2	−16.1	37.5	—	4.4
Petrolite	23¾	−15.2	−18.1	4.4	14	4.6
PPG Industries	62¼	32.4	−10.4	45.6	13	3.1
Reichhold Chemicals	34¾	−14.5	−17.3	18.3	—	2.3
Rohm & Haas	29¾	30.1	−19.0	45.1	16	2.6
Union Carbide	22⅝	41.4	−11.3	20.7	—	6.6
Witco	33	31.3	−14.3	50.0	13	3.3

a Based on net earnings including extraordinary and nonrecurring items. Where company showed a loss, no price/earnings ratio is indicated.

National Starch & Chemical Corp.

Spending on research and development in the U.S. is estimated by the National Science Foundation to reach $118.6 billion this year, an increase of 9% over 1985. That's well below the 12% gains racked up in each of the two previous years. In fact, it's the weakest year-to-year increase in the nation's R&D outlays since 1976.

Slower growth in R&D funding for 1986 shows up pretty well across the board, with both government and industry slated to turn in similar increases and both down from their previous pace. Only academia is swimming against the current; universities and colleges are expected to raise their spending a healthy 14%. But academia is a very small source of R&D funds, contributing a mere 2% of the total.

Much of this year's higher R&D spending—close to half—moreover, stems from rising expenditures for defense. Department of Defense funding of R&D is estimated by NSF to reach $37.9 billion in fiscal 1986, 23% more than in the previous fiscal year. This is on the heels of a 22% increase in fiscal 1985. Defense outlays have more than doubled in just five years—whereas nondefense outlays by federal agencies are essentially unchanged—and now account for two thirds of the overall federal R&D budget,

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compared with just under half in 1981.

Without defense R&D, federal spending would be down 2% this year. The only major funding agencies other than Defense that have budgeted higher spending on R&D are the National Aeronautics & Space Administration, with outlays expected to be up 14%, and NSF itself, targeted to spend 7% more this year than in fiscal 1985.

Future federal spending on R&D, too, may be adversely affected by the Gramm-Rudman-Hollings Act passed by Congress last December. In an effort to curtail government outlays and thereby eliminate the whopping federal deficit, the law requires that the deficit be reduced by steps year by year until a balanced budget is achieved in fiscal 1991. So far, however, the act has had little direct effect on overall R&D spending, observers say.

Industrial R&D spending is rising more slowly this year, as well, because of the generally sluggish U.S. economy and a heightened cost consciousness on the part of management. Concern about such current uncertainties as the outlook for energy costs, interest rates, and the value of the U.S. dollar also is discouraging some companies from taking a gamble on substantial new R&D projects. Major U.S. chemical companies, as a group, are planning practically no increase in R&D budgets this year, for example.

R&D performance can be seen in considerably better light, though, when the dollar figures are adjusted for cost increases. With inflation waning markedly during the past few years, total spending in real dollars will be up 6% in 1986, NSF estimates. That's not quite the equal of the 7 to 8% gains of the two previous years, but it's double the growth rate in real spending during the decade ending with 1983. Prior to that, real growth in R&D funding had been practically nil for several years.

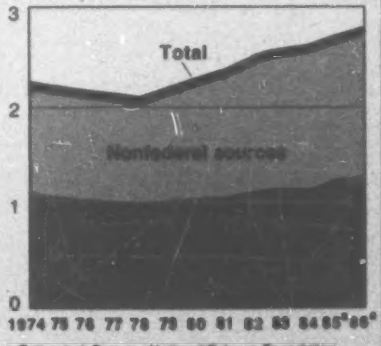
R&D spending now also looks more favorable when stacked up against gross national product, not only because of the growth in scientific efforts in the past few years but because GNP has been expanding in a relatively skimpy fashion recently. NSF figures that total outlays for R&D will be about 2.8% of GNP this year, up slightly from 2.7% in 1985. The percentage has been rising every year since 1978, when it bottomed out at only 2.1% following a long decline from its peak of 3.0% in 1964.

R&D spending relative to GNP is about the same in the U.S. as in West Germany and Japan where, especially in Japan, the percentage also has been growing during the past several years. The U.S. percentage, too, is somewhat higher than the 2.2% level in both the U.K. and France.

But a considerably larger share of the U.S. R&D dollar goes into defense work than is the case with other major industrial nations. Consequently, whereas nondefense outlays for R&D in the U.S. are only 1.9% of GNP, in Japan such outlays are 2.6% and in West Germany 2.5%. Nondefense spending for R&D is 1.8% of GNP for France and 1.6% for the U.K. □

R&D outlays have increased faster than GNP since 1978

R&D spending as % of U.S. gross national product



a Estimated. Source: National Science Foundation

R&D funding continues to expand

With development cutting a bigger piece of the R&D pie, total spending will grow at a relatively low 9% this year

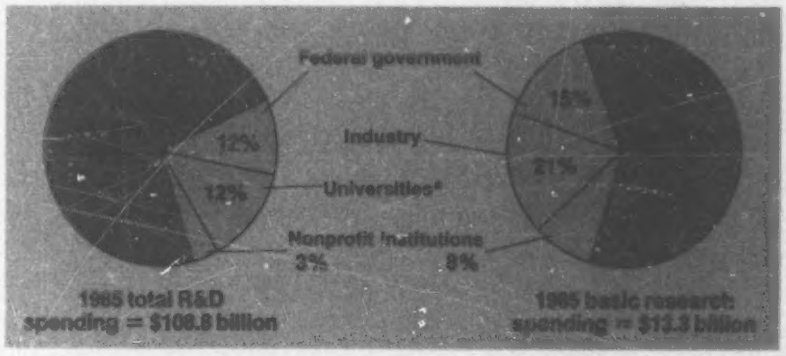
Of the $118.6 billion that will be spent this year on research and development (up 9% from 1985), a hefty 66% will be plowed into development, and 21% will go for applied research and 12% for basic studies. The big D in the R&D picture not only gets the bulk of the funds but it is getting even bigger.

Outlays for development will be up 10% in 1986 and have grown at a 12%-a-year clip during the past decade, while funding of research, up 7% in 1986, has expanded 11% a year since 1976. In that year, 64% of the $39.0 billion devoted to R&D was used for development.

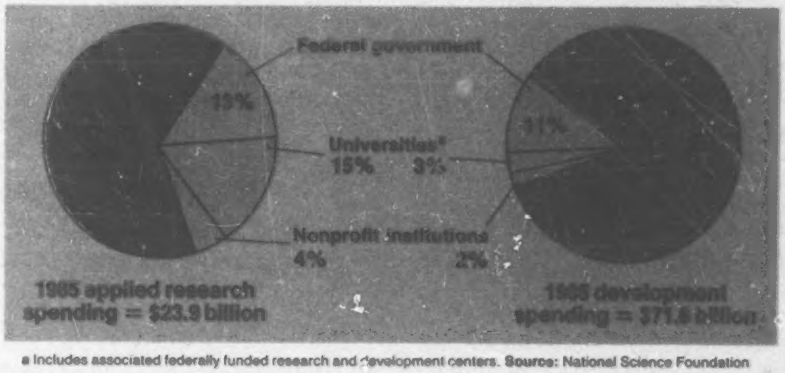
The growth in spending on development partly reflects the growing role of industry in R&D. Industry funds half of U.S. R&D and performs nearly three quarters of it. Industrial R&D has been growing at a rate of 12% a year in the past decade while R&D done elsewhere has been growing at a 10% rate. And 75% of industrial R&D is development.

It also reflects the growing role of defense R&D. Two thirds of federal spending on R&D this year is defense-related, and 90% of that goes into development. Only a third of nondefense federal R&D funds is spent on development.

Industry performs almost three quarters of all R&D, even though universities handle over half of basic research . . .



. . . because company labs do more than two thirds of applied research and a greater share of development



a Includes associated federally funded research and development centers. Source: National Science Foundation

TRENDS IN R&D: Federal share of total spending holds steady during 1980s

% of total outlays	1986[a]	1985[a]	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970	1969	1968
Federal	47%	47%	47%	47%	46%	46%	47%	49%	50%	50%	51%	51%	51%	53%	56%	56%	57%	58%	61%
Defense related	30	30	29	27	25	23	22	23	24	25	26	26	27	30	32	32	33	34	35
Space related	7	6	6	7	7	7	7	7	7	8	8	8	8	8	9	9	10	11	13
Civilian related	10	11	12	13	14	16	18	19	19	17	17	17	16	15	15	15	14	13	13
Nonfederal	53	53	53	53	54	54	53	51	50	50	49	49	49	47	44	44	43	42	39

a Estimated. Source: National Science Foundation

SOURCES OF R&D FUNDS: Half of the total comes from private industry . . .

$ Billions, current	1986[a]	1985[a]	1984	1983	1982	1981	1980	1979	1978	1977	1976	Annual change 1985–86	Annual change 1976–86
Industry	$59.5	$54.4	$48.8	$43.5	$40.1	$35.9	$30.9	$26.1	$22.5	$19.6	$17.7	9%	13%
Federal government	55.2	50.9	45.3	40.7	36.5	33.4	29.5	26.8	23.9	21.6	19.9	9	11
Universities and colleges	2.5	2.2	2.0	1.9	1.7	1.5	1.3	1.2	1.0	0.9	0.8	14	12
Other nonprofit institutions	1.4	1.3	1.2	1.1	1.0	1.0	0.9	0.8	0.8	0.7	0.6	8	9
TOTAL	$118.6	$108.8	$97.3	$87.2	$79.3	$71.8	$62.6	$54.9	$48.1	$42.8	$39.0	9%	12%

a Estimated. Source: National Science Foundation

. . . but universities' contribution, although much smaller, rose most in 1985

$ Billions, constant (1982)	1986[a]	1985[a]	1984	1983	1982	1981	1980	1979	1978	1977	1976	Annual change 1985–86	Annual change 1976–86
Industry	$51.7	$48.7	$45.2	$41.9	$40.1	$38.3	$36.1	$33.2	$31.1	$29.2	$28.1	6%	6%
Federal government	47.9	45.6	41.8	39.1	36.5	35.7	34.5	34.3	33.2	32.2	31.8	5	4
Universities and colleges	2.2	2.0	1.8	1.6	1.7	1.6	1.6	1.5	1.4	1.3	1.3	10	5
Other nonprofit institutions	1.2	1.2	1.1	1.1	1.0	1.0	1.0	1.1	1.1	1.0	1.0	0	2
TOTAL	$103.0	$97.4	$89.9	$83.9	$79.3	$76.6	$73.2	$70.1	$66.8	$63.7	$62.2	6%	5%

a Estimated. Source: National Science Foundation

PERFORMERS OF R&D: Government labs' share of total R&D dollars shrinks . . .

$ Billions, current	1986[a]	1985[a]	1984	1983	1982	1981	1980	1979	1978	1977	1976	Annual change 1985–86	Annual change 1976–86
Industry	$87.0	$79.5	$71.1	$63.4	$58.0	$51.8	$44.5	$38.2	$33.3	$29.8	$27.0	9%	12%
Federal government	14.0	13.2	11.6	10.6	9.1	8.4	7.6	7.4	6.8	6.0	5.8	6	9
Universities and colleges	10.6	9.5	8.5	7.8	7.3	6.8	6.1	5.4	4.6	4.1	3.7	12	11
Associated FFRDCs[b]	3.6	3.4	3.1	2.7	2.5	2.5	2.2	1.9	1.7	1.4	1.1	6	13
Other nonprofit institutions	3.4	3.3	3.0	2.7	2.4	2.3	2.2	2.0	1.7	1.5	1.4	5	9
TOTAL	$118.6	$108.8	$97.3	$87.2	$79.3	$71.8	$62.6	$54.9	$48.1	$42.8	$39.0	9%	12%

a Estimated. b Federally funded research and development centers administered by universities and colleges. Source: National Science Foundation

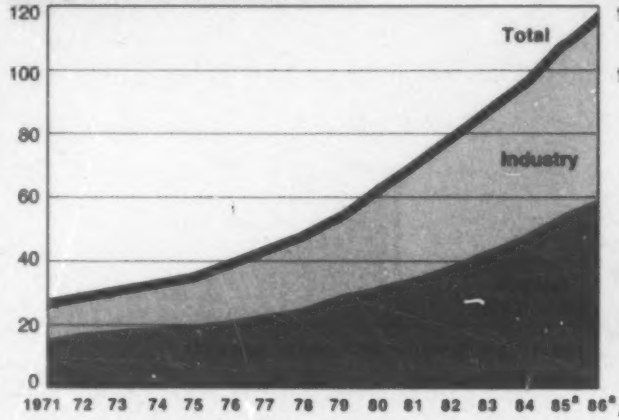
. . . as that for academia expands slightly in recent years

$ Billions, constant (1982)	1986[a]	1985[a]	1984	1983	1982	1981	1980	1979	1978	1977	1976	Annual change 1985–86	Annual change 1976–86
Industry	$75.5	$71.2	$65.8	$61.0	$58.0	$55.2	$51.9	$48.7	$46.1	$44.3	$42.8	6%	6%
Federal government	12.2	11.8	10.7	10.2	9.1	9.0	9.0	9.5	9.5	9.0	9.3	3	3
Universities and colleges	9.2	8.5	7.8	7.5	7.3	7.3	7.1	6.9	6.5	6.1	6.0	8	4
Associated FFRDCs[b]	3.1	3.0	2.9	2.6	2.5	2.7	2.7	2.5	2.4	2.1	1.8	2	6
Other nonprofit institutions	3.0	3.0	2.7	2.6	2.4	2.4	2.5	2.5	2.3	2.2	2.2	0	3
TOTAL	$103.0	$97.4	$89.9	$83.3	$79.3	$76.6	$73.2	$70.1	$66.8	$63.7	$62.1	6%	5%

a Estimated. b Federally funded research and development centers administered by universities and colleges. Source: National Science Foundation

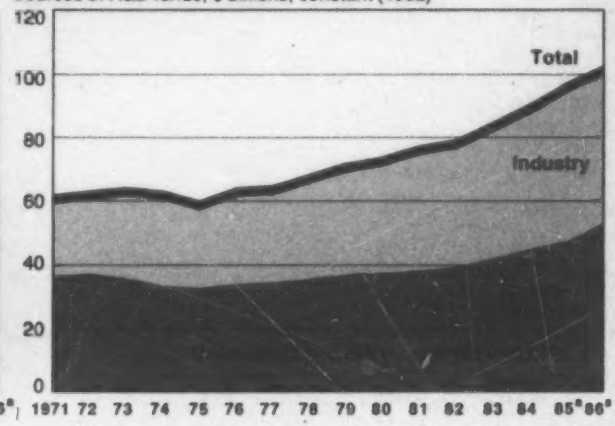
Spending for R&D has nearly doubled since 1980 . . .

Sources of R&D funds, $ billions, current



. . . but is up only 40% after adjustment for inflation

Sources of R&D funds, $ billions, constant (1982)



a Estimated. Source: National Science Foundation

CHARACTER OF R&D: Development's share of funds is biggest and fastest growing . . .

$ Billions, current	1986a	1985a	1984	1983	1982	1981	1980	1979	1978	1977	1976	Annual change 1985–86	Annual change 1976–86
Basic research	$14.5	$13.3	$12.1	$11.0	$ 9.9	$ 9.2	$ 8.1	$ 7.3	$ 6.4	$ 5.5	$ 5.0	8%	7%
Applied research	25.3	23.9	22.3	20.4	18.5	16.9	14.1	12.4	10.8	9.7	9.0	6	11
Development	78.9	71.6	62.9	55.8	50.9	45.8	40.5	35.3	30.9	27.5	25.0	10	12

a Estimated. Source: National Science Foundation

. . . with outlays expected to expand 6% this year in real dollars

$ Billions, constant (1982)	1986a	1985a	1984	1983	1982	1981	1980	1979	1978	1977	1976	Annual change 1985–86	Annual change 1976–86
Basic research	$12.6	$11.9	$11.2	$10.6	$ 9.9	$ 9.8	$ 9.5	$ 9.3	$ 8.9	$ 8.3	$ 8.0	5%	5%
Applied research	22.0	21.4	20.6	19.6	18.5	18.0	16.5	15.8	15.1	14.5	14.4	2	4
Development	68.5	64.1	58.1	53.7	50.9	48.8	47.3	45.0	42.8	40.9	39.7	6	6

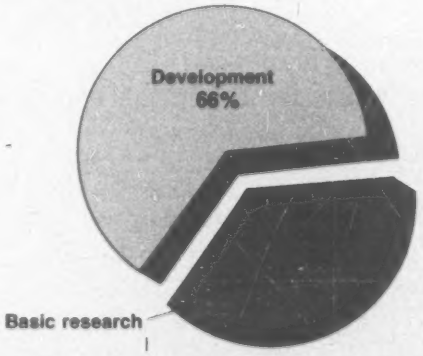
a Estimated. Source: National Science Foundation

EMPLOYED SCIENTISTS AND ENGINEERS: Chemists make up 6% of total

	Thousands employed	Per cent
Scientists	1781.4	44.6%
Physical scientists	254.1	6.4
Chemists	168.6	4.2
Physicists/astronomers	61.2	1.6
Other physical scientists	24.3	0.6
Other scientists	1527.3	38.2
Engineers	2214.1	55.4
Chemical engineers	140.1	3.5
Other engineers	2074.0	51.9
TOTAL	3995.5	100.0

Note: 1984 data. Source: National Science Foundation

About a third of the R&D dollars goes into research



1985 total R&D spending = $108.8 billion

Source: National Science Foundation

ABSTRACTS OF PAPERS IN *CHEMICAL ABSTRACTS*: Organic chemistry's share has dwindled

% IN EACH GROUP	1985	1984	1983	1982	1981	1980	1979	1978	1977
Biochemistry	40.5%	40.5%	38.3%	39.5%	39.0%	39.8%	38.8%	38.3%	37.9%
Physical, inorganic, and analytical chemistry	29.8	28.8	29.6	28.5	28.0	28.6	28.9	27.4	27.9
Applied chemistry and chemical engineering	18.4	17.6	19.4	19.5	19.1	18.9	19.4	20.8	19.7
Organic chemistry	6.4	7.6	7.3	7.2	8.7	7.4	7.6	8.0	8.8
Macromolecular chemistry	4.9	5.5	5.4	5.3	5.2	5.3	5.3	5.5	5.7
% OF ALL BIOCHEMISTRY ABSTRACTS									
Mammalian hormones[a]	12.3%	12.4%	12.9%	12.2%	6.8%	6.0%	5.9%	5.9%	5.5%
Pharmacology	12.3	11.6	11.8	12.0	12.4	12.0	11.9	12.3	12.0
Mammalian biochemistry[a]	11.1	11.3	11.1	11.6	15.6	16.3	17.1	17.2	17.7
Toxicology	7.9	8.0	8.5	8.1	8.7	8.3	7.4	7.5	6.2
Microbial biochemistry[a]	5.7	5.2	5.1	5.3	5.6	5.2	5.3	5.1	5.3
Enzymes	5.6	5.8	6.1	5.9	5.9	6.2	6.4	5.7	6.1
Plant biochemistry[a]	5.5	6.2	5.9	6.2	5.8	5.7	5.8	5.4	5.8
Immunochemistry	5.3	4.8	4.2	4.4	3.4	3.1	3.2	3.6	3.1
Biochemical genetics[b]	5.2	4.2	3.8	3.3	—	—	—	—	—
Biochemical methods	4.9	4.9	4.9	4.6	5.7	5.5	5.4	4.6	5.1
General biochemistry	4.9	5.3	5.8	6.0	7.5	6.6	7.0	6.5	7.0
Others	19.3	20.3	19.9	20.4	22.6	25.1	24.6	26.2	26.2
% OF ALL PHYSICAL, INORGANIC, AND ANALYTICAL CHEMISTRY ABSTRACTS									
Nuclear chemistry	21.8%	22.2%	22.5%	22.6%	21.6%	23.2%	25.1%	20.7%	21.1%
Spectra	18.4	18.0	17.6	17.2	18.0	18.2	17.0	17.0	18.1
Electric phenomena	10.8	10.8	10.0	10.5	11.0	11.2	11.4	10.9	10.5
Crystallography and liquid crystals	7.5	7.8	8.3	8.7	8.9	8.1	8.2	9.2	8.9
General physical chemistry	6.9	6.9	7.3	7.3	7.2	7.1	6.6	6.6	6.8
Analytical chemistry	6.1	6.3	6.2	5.4	5.8	5.6	5.6	7.2	5.8
Others	28.5	28.0	28.1	28.3	27.5	26.6	25.8	28.4	28.8
% OF ALL APPLIED CHEMISTRY AND CHEMICAL ENGINEERING ABSTRACTS									
Water, wastes, and pollution	20.2%	21.0%	19.6%	21.7%	24.0%	22.5%	20.8%	20.8%	23.2%
Metals and alloys	20.0	18.9	19.1	22.2	17.9	22.0	23.6	24.0	24.2
Mineralogical and geological chemistry	12.5	14.6	14.1	13.6	14.1	15.7	15.8	16.8	13.4
Fossil fuels, derivatives, and related products	10.1	10.1	10.3	9.4	9.4	8.9	7.8	8.2	9.2
Unit operations and processes	7.5	7.0	7.5	6.9	6.4	6.0	6.1	6.4	5.8
Others	29.7	28.4	29.4	26.2	28.2	24.9	25.9	23.8	24.2
% OF ALL ORGANIC CHEMISTRY ABSTRACTS									
Physical organic chemistry	30.6%	32.0%	30.5%	31.5%	37.0%	38.8%	38.8%	38.8%	41.3%
Organometallic and organometalloidal compounds[a]	16.2	17.1	16.3	14.8	8.3	8.2	8.5	8.9	8.5
Heterocyclic compounds[a]	16.1	15.6	16.2	15.6	18.2	17.3	16.0	17.5	17.0
Aromatic compounds[a]	6.3	6.3	7.1	7.2	8.7	7.8	8.2	8.6	8.5
Carbohydrates	5.7	5.7	5.8	5.8	5.4	5.7	6.0	5.2	4.6
Biomolecules and their synthetic analogs[b]	4.9	4.4	4.5	3.7	—	—	—	—	—
Amino acids, peptides, and proteins[a]	4.6	4.8	4.5	4.4	4.2	3.7	4.1	4.0	3.7
Aliphatic compounds[a]	4.2	3.6	4.3	5.2	6.6	6.0	6.0	6.9	5.9
Others	11.4	10.5	10.8	11.8	11.6	12.5	12.4	12.1	10.5
% OF ALL MACROMOLECULAR CHEMISTRY ABSTRACTS									
Synthetic high polymers	34.1%	34.0%	34.4%	34.7%	30.3%	27.0%	26.3%	25.6%	26.5%
Plastics manufacture and uses	25.3	24.2	24.4	21.9	26.4	28.1	27.8	28.1	27.5
Cellulose, lignin, paper, and other wood products	9.1	9.6	9.1	9.7	10.1	10.9	11.1	10.6	10.0
Textiles	8.2	7.3	7.9	8.9	9.9	10.1	10.1	12.1	11.0
Coatings, inks, and related products	7.2	7.8	6.6	7.6	7.5	7.4	8.1	7.5	7.5
Synthetic elastomers and natural rubber	6.8	7.3	7.5	7.8	7.9	8.4	7.6	8.0	8.5
Others	9.3	9.8	10.1	9.4	7.9	8.1	9.0	8.1	9.0

a Definition of section content changed in 1982. b New section in 1982. Source: Chemical Abstracts Service

U.S. PATENTS: Percentage granted to foreign residents reaches all-time high

	1985	1984	1983	1982	1981	1980	1979[a]	1978	1977	1976	1975
U.S.[b]	39,554	38,364	32,871	33,896	39,223	37,356	30,081	41,254	41,485	44,280	46,717
Foreign[c]	32,107	28,837	23,989	23,993	26,548	24,463	18,773	24,848	23,784	25,946	25,285
TOTAL	71,661	67,201	56,860	57,889	65,771	61,819	48,854	66,102	65,269	70,226	72,002
% Foreign	44.8%	42.9%	42.2%	41.4%	40.4%	39.6%	38.4%	37.6%	36.4%	36.9%	35.1%

a Patent figures were low in 1979 because the U.S. Patent & Trademark Office was short of funds to print patents it might otherwise have issued. b U.S. patents granted to U.S. residents. c U.S. patents granted to residents of foreign countries. Source: U.S. Patent & Trademark Office

Outlays rise only because of military work

FEDERAL OBLIGATIONS FOR R&D: Defense spending will rise 23% in 1986

Department or agency	Total R&D ($ millions) 1986[a]	1985[a]	1984	1983	1982
Agriculture	$ 882.1	$ 939.1	$ 866.2	$ 847.6	$ 797.3
Agricultural Research Service	468.5	470.9	451.3	443.4	404.9
Cooperative State Research Service	239.2	274.3	235.7	232.3	219.0
Forest Service	104.2	121.0	108.4	107.7	112.1
Commerce	274.7	381.4	358.2	335.0	336.3
National Bureau of Standards	89.4	101.2	95.5	95.0	88.8
National Oceanic & Atmospheric Administration	171.0	261.9	244.3	222.0	222.0
Defense	37,932.5	30,958.5	25,372.9	22,992.8	20,622.6
Air Force	15,957.8	14,207.2	12,091.8	10,812.6	9,357.9
Army	5,445.7	4,836.6	4,225.5	3,998.1	3,760.5
Navy	11,283.8	9,316.8	7,605.6	6,068.2	5,845.1
Defense agencies[b]	5,153.0	2,746.1	1,391.5	2,052.3	1,618.1
Energy	4,593.5	4,848.3	4,673.8	4,536.7	4,708.2
Environmental Protection Agency	330.6	312.4	261.2	240.7	336.1
Health & Human Services	5,142.5	5,454.2	4,830.7	4,352.5	3,940.7
National Institutes of Health	4,560.0	4,835.9	4,257.4	3,789.2	3,433.1
Interior	368.2	410.9	410.9	382.5	381.1
Geological Survey	212.6	213.8	208.9	157.0	152.6
National Aeronautics & Space Administration	3,753.3	3,297.3	2,821.9	2,661.6	3,077.9
National Science Foundation	1,444.6	1,353.1	1,202.8	1,062.0	975.3
Tennessee Valley Authority	67.9	83.3	68.1	63.0	85.0
Others	1,223.4	1,413.5	1,358.4	1,237.1	1,173.1
TOTAL	$56,013.3	$49,452.0	$42,224.9	$38,711.5	$36,432.6

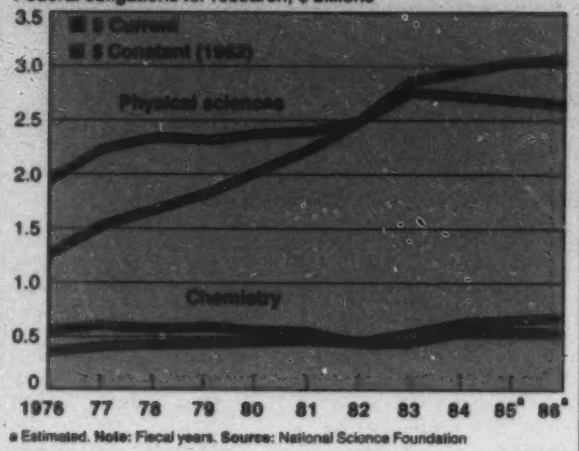
a Estimated. b Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, and others. Note: Fiscal years. Source: National Science Foundation

FEDERAL OBLIGATIONS FOR RESEARCH: Basic research gains modestly as applied declines

Department or agency, $ millions	1986[a] Basic research	1986[a] Applied research	1985[a] Basic research	1985[a] Applied research	1984 Basic research	1984 Applied research	1983 Basic research	1983 Applied research	1982 Basic research	1982 Applied research
Agriculture	$ 416.5	$ 433.0	$ 440.3	$ 466.6	$ 392.6	$ 442.2	$ 362.0	$ 455.5	$ 330.8	$ 435.7
Agricultural Research Service	250.6	190.5	250.6	192.4	240.6	183.7	215.3	202.6	192.9	186.2
Cooperative State Research Service	119.3	119.9	132.0	142.3	99.6	136.2	98.8	133.5	91.3	127.7
Forest Service	40.3	60.9	47.2	70.2	41.2	63.9	38.8	65.1	38.7	69.0
Commerce	17.5	210.0	21.2	290.9	20.6	276.1	19.2	265.6	16.9	259.2
National Bureau of Standards	17.1	63.7	20.0	67.3	20.2	63.5	18.4	63.1	16.5	57.4
National Oceanic & Atmospheric Administration	0	136.2	0	210.2	0	197.7	0	188.9	0	188.5
Defense	964.4	2529.0	830.0	2226.6	847.9	2200.7	785.6	2437.0	686.7	2288.1
Air Force	228.6	591.5	195.4	523.1	192.4	547.7	164.2	524.2	145.8	488.1
Army	267.2	619.1	217.5	507.1	222.1	486.7	208.3	485.3	187.7	451.6
Navy	371.6	481.3	332.3	430.2	315.8	449.6	305.4	521.6	280.3	498.4
Defense agencies[b]	97.1	837.2	84.8	766.2	117.6	716.6	107.7	905.9	72.9	828.1
Energy	937.8	1019.8	915.5	1222.9	830.4	1194.5	767.7	1193.4	642.2	1053.9
Environmental Protection Agency	40.2	170.5	36.6	168.9	29.6	142.3	22.2	152.4	32.7	210.7
Health & Human Services	3055.6	1697.0	3229.9	1809.3	2814.5	1651.5	2475.4	1545.4	2144.7	1460.9
National Institutes of Health	2844.8	1341.3	3021.8	1422.5	2624.8	1285.6	2313.0	1165.2	2020.7	1103.8
Interior	117.7	230.0	137.0	252.9	125.9	254.3	103.0	254.7	76.5	275.0
Geological Survey	81.5	123.5	80.1	129.3	78.9	125.1	64.7	89.9	52.6	99.4
National Aeronautics & Space Administration	835.0	814.2	775.8	846.4	754.5	954.7	617.0	927.8	535.7	971.4
National Science Foundation	1364.9	79.7	1272.8	80.3	1132.3	70.5	999.1	62.9	916.1	57.1
Tennessee Valley Authority	4.7	8.3	5.8	10.0	5.1	9.2	5.8	6.7	4.8	8.1
Others	118.8	651.2	122.0	725.6	114.0	715.4	103.3	692.0	94.7	842.5
TOTAL	$7875.1	$7842.7	$7786.9	$8100.4	$7067.4	$7911.4	$6260.1	$7993.4	$5481.6	$7540.6

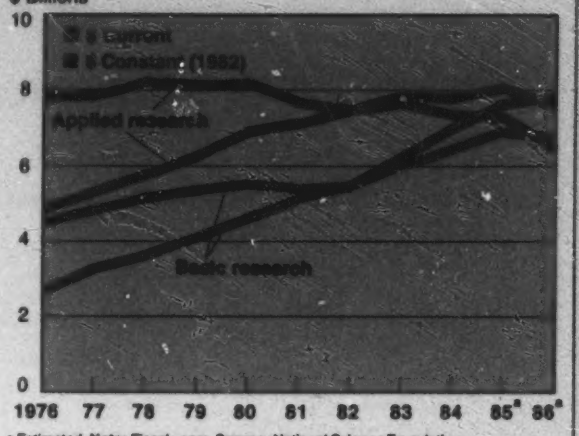
a Estimated. b Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, and others. Note: Fiscal years. Source: National Science Foundation

Federal outlays for chemistry in constant dollars have held steady since 1984



a Estimated. Note: Fiscal years. Source: National Science Foundation

Government support for basic research tops spending on applied research



a Estimated. Note: Fiscal years. Source: National Science Foundation

FEDERAL OBLIGATIONS FOR SCIENTIFIC DISCIPLINES: Research spending drops 1% in 1986

$ Millions for research only	1986a	1985a	1984	1983	1982	1981	Annual change 1986–86	Annual change 1981–86
Engineering	$ 3,537.6	$ 3,503.8	$ 3,624.1	$ 3,517.0	$ 3,296.5	$ 3,071.5	1%	3%
Chemical	136.8	152.4	144.5	145.0	95.1	147.6	−10	−2
Metallurgy and materials	375.7	365.9	341.1	332.5	309.1	256.0	3	8
Environmental sciences	1,315.8	1,358.1	1,275.9	1,251.2	1,148.3	1,121.1	−3	3
Life sciences	6,039.9	6,291.8	5,635.9	5,177.9	4,745.5	4,435.6	−4	6
Mathematics and computer sciences	635.3	579.0	440.3	419.4	350.1	278.9	8	18
Physical sciences	3,040.1	3,036.4	2,969.0	2,891.4	2,500.4	2,220.5	0	6
Chemistry	622.7	611.3	606.4	520.3	481.2	486.9	2	5
Physics	1,822.8	1,848.5	1,836.4	1,854.6	1,610.5	1,345.6	−1	6
Other sciences	1,149.1	1,116.2	1,033.6	996.6	891.4	1,085.2	3	1
TOTAL	$15,717.8	$15,887.3	$14,978.8	$14,253.5	$13,022.2	$12,212.8	−1%	5%

a Estimated. Note: Fiscal years. Source: National Science Foundation

FEDERAL OBLIGATIONS FOR DEVELOPMENT: Defense accounts for most growth this year

Department or agency	Development ($ millions) 1986a	1985a	1984	1983	1982
Agriculture	$ 30.6	$ 32.3	$ 31.3	$ 30.0	$ 30.8
Agricultural Research Service	27.4	27.9	27.0	25.5	25.8
Cooperative State Research Service	0	0	0	0	0
Forest Service	3.0	3.6	3.3	3.6	4.5
Commerce	47.2	69.3	61.5	50.2	60.2
National Bureau of Standards	8.6	14.0	11.8	13.6	14.9
National Oceanic & Atmospheric Administration	34.8	51.7	46.6	33.1	33.5
Defense	34,439.0	27,901.9	22,324.3	19,770.1	17,869.8
Air Force	15,137.5	13,488.7	11,351.5	10,124.2	8,724.0
Army	4,559.4	3,911.9	3,516.8	3,314.5	3,121.3
Navy	10,431.0	8,554.3	6,840.2	5,241.2	5,066.4
Defense agencies[b]	4,218.7	1,895.1	557.3	1,038.7	717.1
Energy	2,635.9	2,709.9	2,648.7	2,575.6	3,012.1
Environmental Protection Agency	119.9	106.9	89.2	66.1	91.7
Health & Human Services	389.9	415.1	364.7	331.7	335.2
National Institutes of Health	373.8	391.6	347.0	311.0	308.7
Interior	20.4	21.1	30.7	24.8	29.8
Geological Survey	7.6	4.5	4.9	2.3	0.5
National Aeronautics & Space Administration	2,104.1	1,675.1	1,112.7	1,116.8	1,670.7
National Science Foundation	0	0	0	0	2.2
Tennessee Valley Authority	55.0	67.6	53.8	50.7	72.3
Others	453.5	585.5	529.2	442.0	435.8
TOTAL	$40,295.5	$33,564.7	$27,248.1	$24,458.0	$23,410.4

a Estimated. b Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, and others. Note: Fiscal years. Source: National Science Foundation

BASIC RESEARCH: Funding for chemistry is expected to rise 3% this year

Department or agency	Federal obligations ($ millions)									
	1986[a]		1985[a]		1984		1983		1982	
	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry
Agriculture	$ 46.5	$ 44.6	$ 47.5	$ 45.5	$ 45.4	$ 43.5	$ 40.0	$ 38.2	$ 36.2	$ 34.5
Agricultural Research Service	38.9	37.5	38.9	37.5	37.4	36.0	33.5	32.2	30.0	28.9
Cooperative State Research Service	5.0	5.0	5.6	5.6	5.4	5.4	4.1	4.1	3.8	3.8
Forest Service	2.6	2.1	3.0	2.4	2.6	2.1	2.4	1.9	2.4	1.8
Commerce	15.1	5.3	17.7	6.9	16.3	4.8	15.7	4.7	13.7	4.2
National Bureau of Standards	15.1	5.3	17.1	6.2	16.3	4.8	15.7	4.6	13.7	4.2
Defense	240.4	72.2	215.2	63.1	212.2	60.0	198.4	55.6	188.7	51.5
Air Force	59.4	25.8	52.8	22.0	48.3	20.3	39.3	17.5	34.2	13.9
Army	67.4	21.7	58.4	18.2	59.8	19.1	58.7	19.4	59.6	20.0
Navy	112.7	24.8	100.7	22.9	100.4	20.7	98.0	18.7	93.1	17.7
Defense agencies[b]	0.9	0	3.3	0	3.7	0	2.5	0	1.8	0
Energy	773.1	91.7	748.7	91.3	685.4	108.4	639.2	104.3	530.8	75.5
Environmental Protection Agency	6.2	6.2	5.8	5.8	3.0	3.0	2.3	1.9	3.8	3.5
Health & Human Services	78.8	71.1	83.4	75.3	72.0	65.0	61.8	55.0	53.2	48.0
National Institutes of Health	76.8	69.1	81.5	73.4	70.8	63.8	60.9	54.2	52.9	47.7
Interior	7.6	6.0	7.6	6.0	7.1	5.6	2.9	1.8	8.1	2.5
Geological Survey	7.5	5.9	7.5	6.0	7.1	5.6	2.6	1.8	2.8	1.9
National Aeronautics & Space Administration	433.6	8.4	371.8	7.1	338.7	5.4	329.5	7.7	280.6	5.2
National Science Foundation	388.1	126.8	368.0	119.4	330.2	106.8	283.5	85.5	266.6	83.3
Tennessee Valley Authority	2.7	0	4.0	0	3.7	0	3.5	3.5	3.0	3.0
Others	11.1	0.3	12.1	0.4	11.0	0.9	10.4	1.0	9.1	0.8
TOTAL	$2003.2	$432.6	$1881.8	$420.8	$1728.0	$403.4	$1587.2	$362.2	$1393.8	$312.0

a Estimated. b Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, and others. **Note:** Fiscal years. **Source:** National Science Foundation

APPLIED RESEARCH: Chemical work stresses defense, agriculture, and health

Department or agency	Federal obligations ($ millions)									
	1986[a]		1985[a]		1984		1983		1982	
	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry
Agriculture	$ 27.0	$ 25.1	$ 28.6	$ 26.6	$ 27.3	$ 25.5	$ 27.6	$ 25.6	$ 26.0	$ 24.0
Agricultural Research Service	17.5	16.2	17.7	16.4	16.9	15.6	18.6	17.2	17.1	15.8
Cooperative State Research Service	7.2	7.2	8.3	8.3	8.1	8.1	6.7	6.7	6.4	6.4
Forest Service	2.3	1.7	2.7	2.0	2.4	1.8	2.3	1.7	2.6	1.7
Commerce	36.3	11.5	37.1	11.2	36.9	10.5	33.9	9.3	32.6	8.8
National Bureau of Standards	28.1	10.4	26.3	9.2	28.1	9.3	26.7	8.1	25.4	7.3
Defense	396.8	87.6	395.1	74.8	477.2	79.8	562.0	66.3	500.0	66.6
Air Force	62.1	17.9	54.9	15.8	58.6	16.4	54.5	13.7	50.5	13.3
Army	117.5	56.0	100.7	46.9	77.4	47.2	86.9	39.9	83.2	41.4
Navy	71.5	13.4	62.6	11.6	69.2	15.9	135.2	12.3	128.7	11.7
Defense agencies[b]	145.7	0.4	176.8	0.4	272.1	0.3	285.4	0.3	237.6	0.3
Energy	477.6	9.3	596.2	16.1	603.5	32.0	584.8	13.3	482.8	29.9
Environmental Protection Agency	11.6	11.6	13.8	13.8	13.8	12.9	13.9	12.8	16.6	15.3
Health & Human Services	26.7	23.1	28.0	24.3	24.7	21.3	22.6	19.2	17.6	15.3
National Institutes of Health	24.7	21.1	26.1	22.4	23.6	20.3	21.5	18.1	17.2	14.9
Interior	15.9	13.3	16.1	13.7	15.7	13.6	5.5	4.4	10.2	3.7
Geological Survey	15.0	13.0	15.4	13.3	14.9	12.8	4.7	3.8	4.0	3.2
National Aeronautics & Space Administration	25.4	3.2	21.1	2.2	25.6	1.9	40.4	1.7	8.9	1.0
National Science Foundation	14.8	4.6	13.9	4.3	10.9	3.1	9.4	3.9	6.0	2.8
Others	3.9	0.8	4.6	1.5	5.4	2.4	4.2	1.6	5.8	1.8
TOTAL	$1037.0	$190.1	$1154.5	$190.5	$1241.0	$203.0	$1304.3	$158.1	$1106.5	$169.2

a Estimated. b Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, and others. **Note:** Fiscal years. **Source:** National Science Foundation

OBLIGATIONS FOR ENGINEERING RESEARCH: Support for chemical engineering declines

Department or agency	Federal obligations ($ millions)									
	1986[a]		1985[a]		1984		1983		1982	
	Engineering	Chemical engineering	Engineering	Chemical engineering	Engineering	Chemical engineering	Engineering	Chemical engineering	Engineering	Chemical engineering
Agriculture	$ 57.0	$ 6.4	$ 59.4	$ 6.9	$ 56.7	$ 6.4	$ 54.7	$ 6.2	$ 51.2	$ 5.8
Agricultural Research Service	33.4	3.3	33.6	3.3	32.2	3.2	32.9	3.2	30.0	2.9
Cooperative State Research Service	9.8	0	9.7	0	10.2	0	7.4	0	6.9	0
Forest Service	13.8	3.1	16.0	3.6	14.3	3.1	14.4	3.0	14.2	2.9
Commerce	33.8	1.4	39.0	1.5	35.3	1.8	37.4	1.3	32.0	2.0
National Bureau of Standards	28.6	1.4	32.2	1.5	28.0	1.8	29.4	1.3	23.8	2.0
Defense	1609.6	39.3	1448.8	35.3	1488.4	38.4	1573.9	44.9	1473.3	39.0
Air Force	481.7	3.4	423.8	2.1	439.5	3.5	419.3	3.1	387.3	2.9
Army	398.0	24.7	320.6	21.3	324.8	23.5	318.9	29.3	297.2	24.4
Navy	425.8	11.2	377.9	11.8	398.4	11.3	395.5	11.9	378.0	11.6
Defense agencies[b]	304.1	0	326.5	0.1	325.7	0.2	440.2	0.6	410.8	0.2
Energy	408.6	32.3	462.2	46.1	439.0	46.1	440.2	51.9	420.8	1.1
Environmental Protection Agency	41.5	15.8	50.7	23.3	37.8	17.8	47.8	16.7	76.4	26.0
Health & Human Services	54.1	0	57.4	0	50.9	0	39.7	0	41.4	0
National Institutes of Health	53.9	0	57.2	0	50.7	0	39.7	0	41.4	0
Interior	70.9	4.7	106.4	4.7	111.4	4.5	91.4	0.4	87.1	1.4
Geological Survey	6.6	4.2	7.1	4.2	8.0	4.1	5.7	0	8.2	0.2
National Aeronautics & Space Administration	843.7	0.4	845.5	0.3	967.8	0.3	799.6	1.0	771.7	0.4
National Science Foundation	214.5	35.4	195.1	32.9	164.9	27.7	142.5	21.5	129.9	18.8
Others	203.9	1.1	239.3	1.4	271.9	1.5	286.8	1.1	297.6	0.6
TOTAL	$3537.6	$136.8	$3503.8	$152.4	$3624.1	$144.5	$3517.0	$145.0	$3386.5	$95.1

a Estimated. b Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, and others. Note: Fiscal years. Source: National Science Foundation

UNIVERSITY RESEARCH: Chemistry's share of government funds is nearly unchanged

Federal obligations, $ millions	1986[a]	1985[a]	1984	1983	1982	1981	1980	Annual change 1985–86	Annual change 1980–86
Engineering	$ 566.8	$ 521.2	$ 474.2	$ 408.7	$ 361.5	$ 365.3	$ 323.7	9%	10%
Chemical	53.1	55.9	51.2	23.6	19.4	21.9	20.3	−5	17
Metallurgy and materials	105.8	98.2	87.7	86.0	75.3	69.5	57.3	8	11
Environmental sciences	364.4	340.7	319.5	316.9	274.7	280.3	297.0	7	3
Life sciences	3055.6	3221.4	2600.2	2460.0	2205.0	2117.2	1984.7	−5	7
Mathematics and computer sciences	288.3	250.2	181.6	172.4	139.7	121.4	94.6	15	20
Physical sciences	829.2	784.0	697.8	596.5	559.1	525.2	461.0	6	10
Chemistry	276.0	276.7	242.3	205.7	189.6	193.5	159.5	0	10
Physics	433.5	408.9	375.2	328.8	306.0	274.5	246.1	6	10
Other sciences	317.2	338.9	304.1	297.8	255.7	297.5	302.7	−6	1
TOTAL	$5421.5	$5456.4	$4777.4	$4252.3	$3795.7	$3706.9	$3463.6	−1%	8%

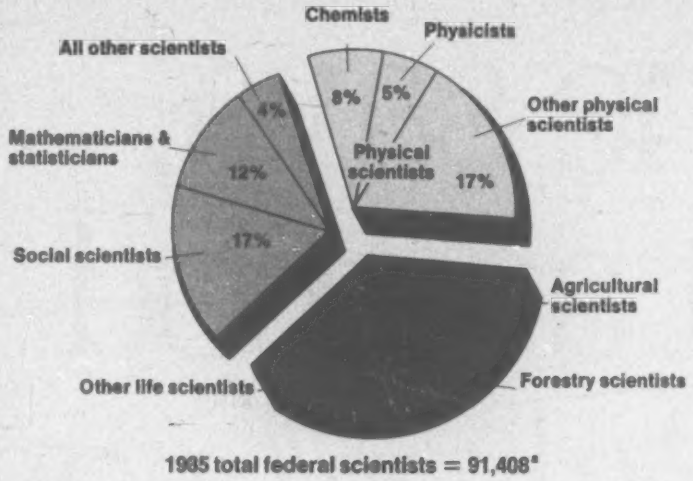
a Estimated. Note: Fiscal years. Source: National Science Foundation

UNIVERSITY BASIC RESEARCH: Basic chemistry gains slightly higher federal support

Federal obligations, $ millions	1986[a]	1985[a]	1984	1983	1982	1981	1980	Annual change 1985–86	Annual change 1980–86
Engineering	$ 418.8	$ 377.6	$ 340.3	$ 295.5	$ 259.0	$ 237.3	$ 208.4	11%	12%
Chemical	34.9	33.5	29.6	18.9	16.8	19.8	16.9	4	13
Metallurgy and materials	93.5	85.4	79.9	76.8	69.6	62.6	51.9	9	10
Environmental sciences	330.5	308.9	286.9	284.3	256.0	241.6	255.3	7	4
Life sciences	2210.1	2313.3	1979.6	1701.7	1483.7	1314.6	1219.5	−4	10
Mathematics and computer sciences	189.1	164.5	152.6	146.8	118.8	102.6	79.8	15	15
Physical sciences	701.1	656.8	581.9	502.2	455.3	434.7	375.9	7	11
Chemistry	246.4	237.0	212.1	181.9	165.3	164.7	136.1	4	10
Physics	343.8	326.7	293.9	264.7	238.6	222.4	194.3	5	10
Other sciences	164.9	164.5	147.4	147.2	120.5	148.2	152.4	0	1
TOTAL	$4014.5	$3985.6	$3490.7	$3077.7	$2693.3	$2479.0	$2291.3	1%	10%

a Estimated. Note: Fiscal years. Source: National Science Foundation

About 8% of government scientists are chemists



1985 total federal scientists = 91,408[a]

a As of October 1985; does not include computer specialists. **Source:** National Science Foundation

SCIENTISTS AND ENGINEERS BY AGENCY: Half work for Defense Department

Department or agency	Physical scientists	Chemists	Physicists	Engineers	Chemical engineers	Other scientists[a]	Total scientists and engineers[a]
Agriculture	1,504	887	23	2,915	55	25,524	29,943
Commerce	3,714	319	525	761	35	4,570	9,045
Defense	9,171	2086	3160	70,772	1023	39,491	119,434
Air Force	1,090	313	446	12,044	78	6,030	19,164
Army	3,191	918	759	24,899	513	14,189	42,279
Navy	4,068	764	1932	32,117	414	12,012	48,197
Others	822	91	23	1,712	18	7,260	9,794
Energy	741	167	85	2,711	133	905	4,357
Environmental Protection Agency	1,828	599	17	1,946	162	1,226	5,000
Health & Human Services	2,152	2002	86	349	16	7,175	9,676
Interior	5,166	429	41	3,138	95	7,762	16,066
National Aeronautics & Space Administration	1,131	27	242	9,363	50	841	11,335
Tennessee Valley Authority	200	94	0	3,541	175	658	4,399
Transportation	91	26	5	4,495	11	1,480	6,066
Veterans Administration	586	499	43	1,115	0	3,642	5,343
Others	1,319	454	53	3,987	41	12,071	17,377
TOTAL	27,603	7589	4290	105,093	1796	105,345	238,041

a Includes computer specialists. **Note:** Data as of October 1985. **Source:** National Science Foundation

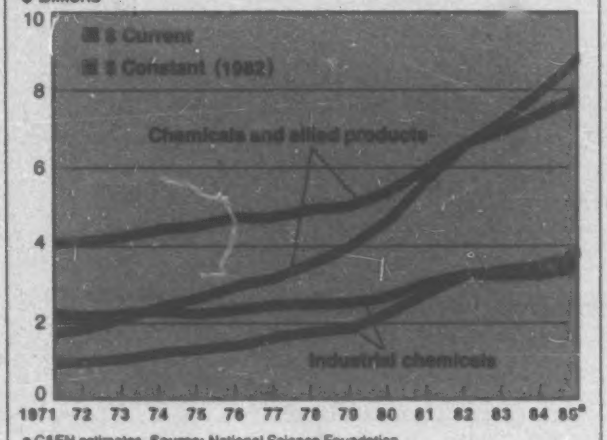
FEDERAL SCIENTISTS AND ENGINEERS: Number of chemists has fallen from 1978 peak

Thousands	1985	1984	1983	1981	1980	1979	1978	1977	1976	1975	1974	1973
Physical scientists	27.6	26.5	27.1	27.4	27.6	27.6	27.5	27.1	27.1	26.7	26.3	26.4
Chemists	7.6	7.6	7.7	7.9	8.1	8.1	8.3	8.0	8.1	8.0	7.8	8.0
Physicists	4.3	4.3	4.4	4.5	4.6	4.9	5.0	5.1	5.3	5.4	5.5	5.6
Engineers	105.1	99.1	94.3	90.9	89.6	88.6	89.2	87.8	87.0	86.6	82.5	84.3
Chemical	1.8	1.7	1.5	1.4	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.5
Computer specialists	41.5	36.2	35.2	na	na	na	na	na	na	na	na	na
Other scientists	63.8	62.7	62.3	59.3	60.8	58.3	57.2	54.3	51.6	50.6	48.8	48.4
TOTAL	238.0	226.5	218.9	177.5	178.0	174.7	173.9	169.2	165.7	163.9	157.6	159.1

Note. As of October of each year. Includes computer specialists. No data for 1982. na = not available. **Source:** National Science Foundation

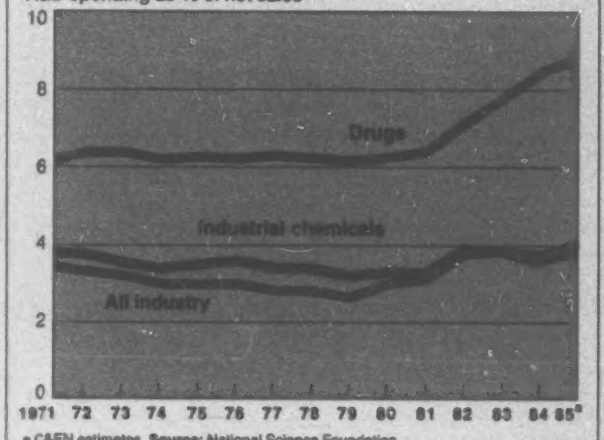
Growth eases a bit for industrial R&D

R&D spending by chemical companies is higher in both current and real dollars



a C&EN estimates. Source: National Science Foundation

R&D spending has been gaining a larger share of industry's revenues



a C&EN estimates. Source: National Science Foundation

TOTAL FUNDS FOR INDUSTRIAL R&D: Chemical producers increase their spending 11%

$ Millions	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	Annual change 1984–85	Annual change 1975–85
Chemicals and allied products	$ 8,900[a]	$ 8,024	$ 7,293	$ 6,659	$ 5,625	$ 4,636	$ 4,038	$ 3,580	$ 3,202	$ 3,017	$ 2,727	11%	13%
Industrial chemicals	3,950[a]	3,548	3,411	3,301	2,802	2,197	1,962	1,798	1,666	1,524	1,391	11	11
Drugs	4,950[a]	4,476	3,882	3,358	2,823	1,777	1,517	1,308	1,117	1,091	881	11	14
Other chemicals						662	559	474	417	401	354		
Other industries	70,600[a]	63,643	56,110	51,337	46,185	39,869	34,188	29,724	26,623	23,960	21,460	11	13
TOTAL	$79,500	$71,667	$63,403	$57,996	$51,810	$44,505	$38,226	$33,304	$29,825	$26,997	$24,187	11%	13%

a C&EN estimates. Source: National Science Foundation

COMPANY FUNDS FOR INDUSTRIAL R&D: Industry pumps more of its own money into R&D

$ Millions	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	Annual change 1984–85	Annual change 1975–85
Chemicals and allied products	$ 8,650[a]	$ 7,802	$ 6,845	$ 6,226	$ 5,205	$ 4,264	$ 3,692	$ 3,250	$ 2,907	$ 2,751	$ 2,490	11%	13%
Industrial chemicals	3,710[a]	3,334	2,970	2,879	2,393	1,856	1,617	1,473	1,387	1,275	1,173	11	12
Drugs	3,785[a]	3,401	2,937	2,490	2,064	1,755	2,075	1,777	1,520	1,476	1,317	11	14
Other chemicals	1,155[a]	1,066	938	856	747	653							
Other industries	44,850[a]	40,803	36,016	33,286	30,223	26,212	22,016	18,865	16,433	14,685	13,092	10	13
TOTAL	$53,500	$48,605	$42,861	$39,512	$35,428	$30,476	$25,708	$22,115	$19,340	$17,436	$15,582	10%	13%

a C&EN estimates. Source: National Science Foundation

FEDERAL FUNDS FOR INDUSTRIAL R&D: Only 1% goes to the chemical industry

$ Millions	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	Annual change 1984–85	Annual change 1975–85
Chemicals and allied products	$ 250[a]	$ 222[b]	$ 448	$ 434	$ 421	$ 372	$ 346	$ 330	$ 295	$ 286	$ 236	13%	1%
Industrial chemicals	240[a]	213[b]	440	423	409	341	345	325	281	249	218	13	1
Drugs and other chemicals	10[a]	9	8	11	12	31	1	5	14	17	18	11	−5
Other industries	25,750	22,850	20,094	18,049	15,961	13,657	12,172	10,859	10,190	9,295	8369	13	12
TOTAL	$26,000	$23,072	$20,542	$18,483	$16,382	$14,025	$12,518	$11,189	$10,485	$9,581	$8605	13%	12%

a C&EN estimates. b The decline in 1984 from 1983 results from a change in the administration of federally funded Oak Ridge National Laboratory from a chemical company to a company in the aircraft and missiles industry. Source: National Science Foundation

R&D BY U.S. COMPANIES ABROAD: Chemical companies boost spending outside U.S.

$ Millions	1985[a]	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	Annual change 1984–85	Annual change 1975–85
Chemicals and allied products	$ 800	$ 760	$ 732	$ 684	$ 715	$ 603	$ 500	$ 395	$ 332	$ 312	$ 269	5%	12%
Industrial and other chemicals	380	357	354	313	287	245	199	151	133	108	85	6	16
Drugs	420	403	378	371	428	357	301	244	199	204	184	4	9
Other industries	3000	2775	2544	2413	2679	2562	2254	1814	1545	1347	1185	8	10
TOTAL	$3800	$3535	$3276	$3098	$3393	$3165	$2754	$2209	$1877	$1659	$1454	7%	10

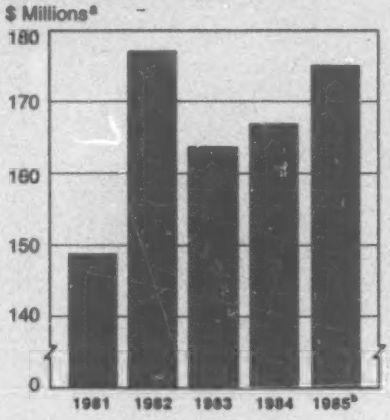
a C&EN estimates. Source: National Science Foundation

CHEMICAL R&D SPENDING: Budget cuts balance increases among major companies

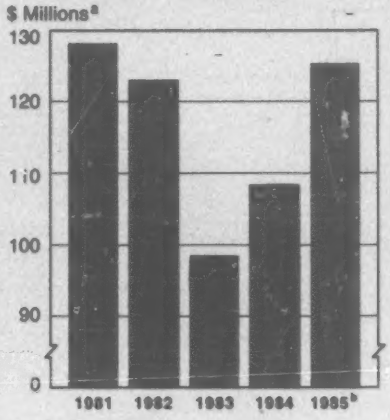
$ Millions	1986[a]	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976
Air Products	$ 60	$ 51	$ 44	$ 40	$ 37	$ 32	$ 30	$ 24	$ 23	$ 24	$ 19
American Cyanamid	265	251	232	208	185	166	148	130	108	96	83
Celanese	105	103	94	85	100	104	94	92	83	77	70
Dow Chemical	600	547	507	492	460	404	314	269	232	203	188
Du Pont[b]	1030	1080	1000	875	775	647	591	509	461	367	353
Ethyl	47	47	40	39	39	37	34	29	25	28	25
W. R. Grace	100	92	81	73	64	57	45	42	37	32	28
Hercules	69	76	72	74	74	65	57	50	43	40	37
Monsanto	520	470	370	290	264	233	208	161	136	132	114
Olin	59	53	52	49	45	38	31	26	25	25	23
PPG Industries[c]	176	176	150	127	127	119	103	83	70	61	56
Rohm & Haas	125	124	109	100	92	77	67	54	49	45	43
Union Carbide[d]	191	275	265	245	240	207	166	161	156	156	143
TOTAL	$3347	$3345	$3016	$2697	$2502	$2186	$1888	$1630	$1448	$1296	$1182
ANNUAL CHANGE	0%	11%	12%	8%	14%	16%	16%	13%	12%	9%	9%

a Planned. b Excludes petroleum and coal segments. c Historical figures net of taxes and depreciation; 1986 estimated. d Company is divesting a substantial share of assets this year; restated on a continuing operations basis, 1985 R&D spending total was $207 million. Sources: Company data and estimates

Chemical firms' funding of energy R&D is up slightly . . .



. . . but outlays on pollution control R&D rebound



a Excludes federal funds. b C&EN estimates. Source: National Science Foundation

BASIC RESEARCH IN INDUSTRY: More than a fourth done by chemical firms

$ Millions	1984	1983	1981	1979	1977	1976	1975	1974
Chemicals and allied products	**$ 677**	**$ 650**	**$ 569**	**$ 366**	**$337**	**$332**	**$298**	**$294**
Industrial chemicals	375	370	360	190	183	168	155	130
Drugs	302	280	185	150	130	128	113	118
Other chemicals			23	26	25	36	31	46
Other industries	**1901**	**1521**	**1045**	**792**	**574**	**505**	**432**	**415**
TOTAL	**$2578**	**$2171**	**$1614**	**$1158**	**$911**	**$837**	**$730**	**$709**

Note: No data for 1978, 1980, and 1982. Sources: National Science Foundation and C&EN estimates based on NSF data

APPLIED RESEARCH IN INDUSTRY: Gets about 40% of chemical industry's R&D

$ Millions	1984	1983	1981	1979	1977	1976	1975	1974
Chemicals and allied products	**$ 3,265**	**$ 2,702**	**$ 2,391**	**$1726**	**$1347**	**$1219**	**$1102**	**$ 965**
Industrial chemicals	1,532	1,486	1,250	853	695	593	537	565
Drugs	1,733	1,216	890	684	479	470	426	299
Other chemicals			251	189	173	156	138	101
Other industries	**12,004**	**10,803**	**8,321**	**5499**	**4289**	**3964**	**3477**	**3292**
TOTAL	**$15,269**	**$13,505**	**$10,712**	**$7225**	**$5636**	**$5183**	**$4578**	**$4257**

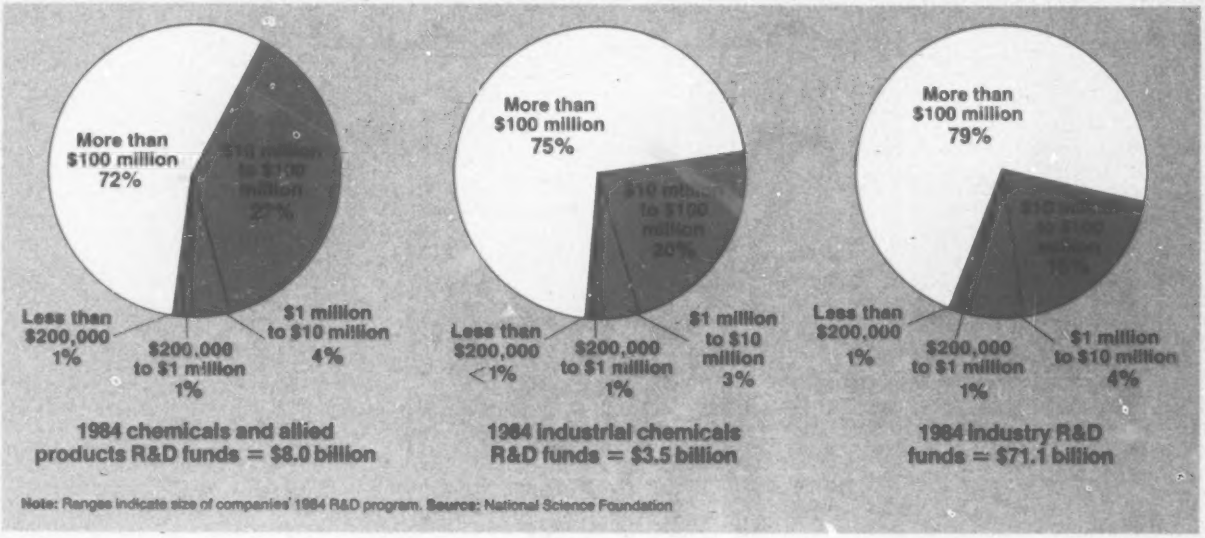
Note: No data for 1978, 1980, and 1982. Sources: National Science Foundation and C&EN estimates based on NSF data

DEVELOPMENT IN INDUSTRY: Chemical industry accounts for nearly 8% of total

$ Millions	1984	1983	1981	1979	1977	1976	1975	1974
Chemicals and allied products	**$ 4,082**	**$ 3,941**	**$ 2,665**	**$ 1,946**	**$ 1,518**	**$ 1,486**	**$ 1,330**	**$ 1,191**
Industrial chemicals	1,641	1,555	1,191	920	790	783	700	604
Drugs	2,441	2,386	1,000	682	508	493	444	390
Other chemicals			475	344	219	209	184	197
Other industries	**49,738**	**43,786**	**36,819**	**27,897**	**21,760**	**19,511**	**17,550**	**16,730**
TOTAL	**$53,820**	**$47,727**	**$39,484**	**$29,843**	**$23,278**	**$20,977**	**$18,879**	**$17,921**

Note: No data for 1978, 1980, and 1982. Sources: National Science Foundation and C&EN estimates based on NSF data

More than 70% of R&D is done by firms that spend some $100 million on it annually


More than $100 million 72%
$1 million to $10 million 4%
$200,000 to $1 million 1%
Less than $200,000 1%
1984 chemicals and allied products R&D funds = $8.0 billion
More than $100 million 75%
$1 million to $10 million 3%
$200,000 to $1 million 1%
Less than $200,000 <1%
1984 industrial chemicals R&D funds = $3.5 billion
More than $100 million 79%
$1 million to $10 million 4%
$200,000 to $1 million 1%
Less than $200,000 1%
1984 industry R&D funds = $71.1 billion

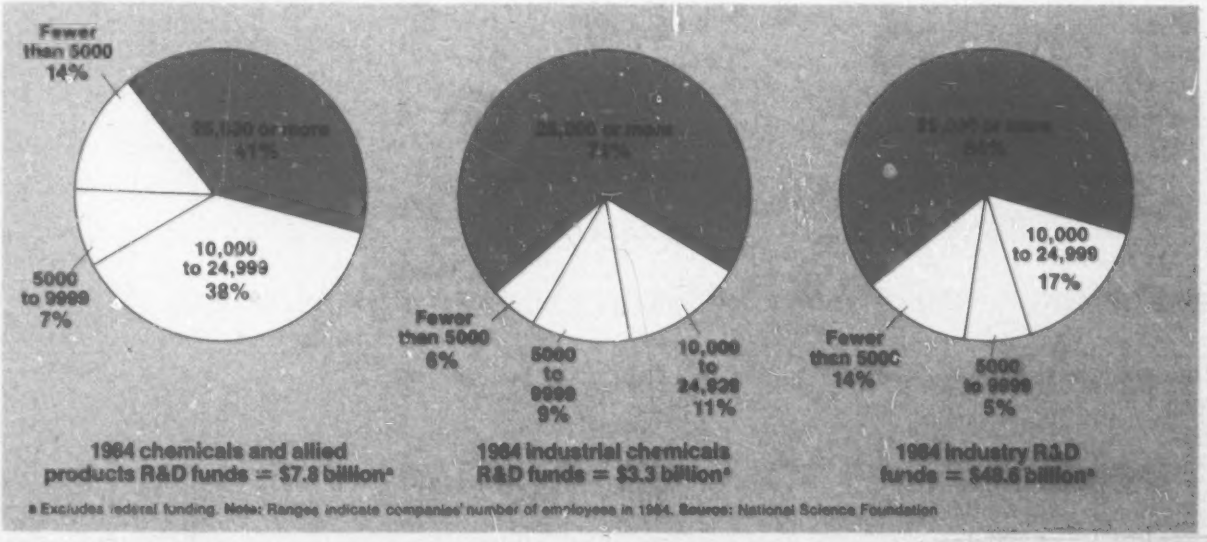
Note: Ranges indicate size of companies' 1984 R&D program. Source: National Science Foundation

R&D SCIENTISTS AND ENGINEERS IN INDUSTRY: Down in industrial chemicals but up for drugs

Thousands[a]	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975
Chemicals and allied products	**66.9**	**67.1**	**66.0**	**61.6**	**54.7**	**51.4**	**50.0**	**48.3**	**46.4**	**44.4**	**45.2**
Industrial chemicals	25.1	26.7	27.2	25.9	21.6	20.9	21.4	21.3	20.6	20.1	21.1
Drugs	30.9	30.1	28.2	25.6	23.3	21.6	20.9	19.5	17.8	16.6	15.6
Other chemicals	10.9	10.3	10.6	10.1	9.8	8.9	7.9	7.5	8.0	7.8	8.5
Other industries	**503.4**	**477.4**	**456.1**	**448.2**	**433.1**	**399.2**	**373.9**	**356.1**	**336.4**	**320.0**	**318.1**
TOTAL	**570.3**	**544.5**	**522.1**	**509.8**	**487.8**	**450.6**	**423.9**	**404.4**	**382.8**	**364.4**	**363.3**

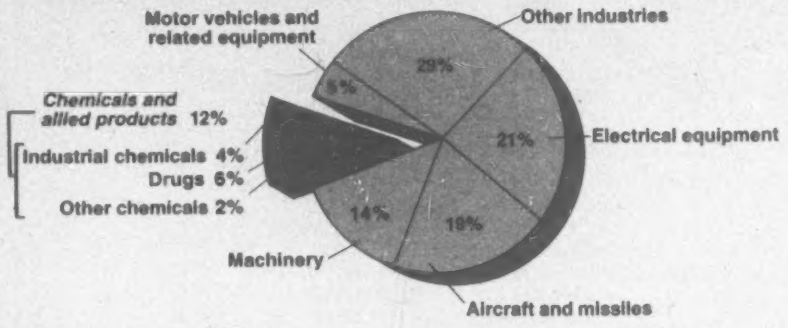
a Full-time equivalent. Note: Data as of January of each year. Source: National Science Foundation

Firms with more than 25,000 employees do major share of R&D


Fewer than 5000 14%
10,000 to 24,999 38%
5000 to 9999 7%
1984 chemicals and allied products R&D funds = $7.8 billion[a]
Fewer than 5000 6%
5000 to 9999 9%
10,000 to 24,999 11%
1984 industrial chemicals R&D funds = $3.3 billion[a]
10,000 to 24,999 17%
Fewer than 5000 14%
5000 to 9999 5%
1984 industry R&D funds = $49.6 billion[a]

a Excludes federal funding. Note: Ranges indicate companies' number of employees in 1984. Source: National Science Foundation

Chemical industry employs 12% of scientists and engineers doing industrial research



1985 total industrial R&D scientists and engineers[a] = 570,300

a Full-time equivalent, as of January 1985. Source: National Science Foundation

R&D SCIENTISTS AND ENGINEERS PER 1000 EMPLOYEES: Down slightly for chemical firms

	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972
Chemicals and allied products	53	54	51	44	42	42	43	42	40	41	40	39	39
Industrial chemicals	42	45	44	37	36	36	38	38	36	36	37	36	34
Drugs	88	82	74	66	60	62	65	62	64	59	57	57	60
Other chemicals	36	36	36	33	30	27	27	29	28	29	30	29	31
All industry	36	35	33	29	27	27	27	27	27	26	25	24	24

Source: National Science Foundation

COST PER INDUSTRIAL R&D SCIENTIST OR ENGINEER: Nearly twice what it was in mid-1970s

$ Thousands	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974
Chemicals and allied products	$119.8	$109.6	$104.4	$ 96.6	$ 87.4	$79.6	$72.8	$67.6	$66.5	$60.9	$56.3
Industrial chemicals	137.0	126.6	124.3	118.0	103.4	92.8	84.2	79.6	74.7	67.5	63.5
Drugs	a	a	a	a	79.2	71.4	64.8	59.9	63.4	60.9	54.3
Other chemicals	a	a	a	a	66.5	66.5	61.6	53.8	50.8	43.2	45.3
All industry	$127.6	$118.9	$112.4	$103.9	$ 94.9	$87.4	$80.4	$75.8	$72.2	$66.5	$63.3

a Not separately available but included in chemicals and allied products. Source: National Science Foundation

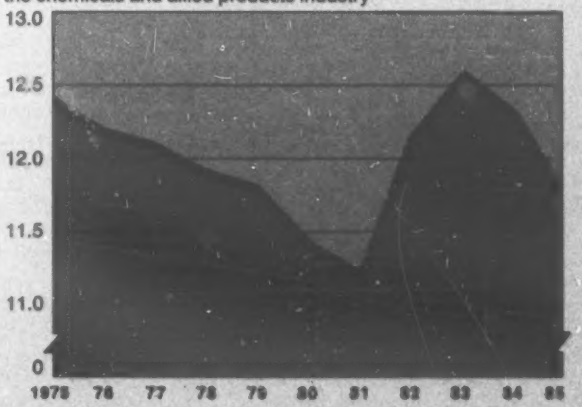
CHEMISTS IN INDUSTRY: More Ph.D.s work for chemical industry than any other industry

Industry	% of industrial chemists			
	All chemists	B.S.	M.S.	Ph.D.
Pharmaceuticals[a]	18%	17%	19%	18%
Chemicals[b]	16	13	15	19
Agricultural chemicals	7	5	6	9
Petroleum and natural gas	6	5	5	8
Coatings	6	8	6	4
Electronics	5	6	5	5
Biochemicals and biotechnology	4	3	3	5
Food	4	5	5	3
Metals and minerals	3	4	3	2
Soaps and detergents	3	3	3	2
Rubber	2	3	3	2
Paper	2	2	1	2
Other manufacturing	17	17	17	16
Nonmanufacturing	7	10	9	5

a Includes personal-care products. b Excludes chemical fields listed separately. Source: 1986 ACS survey

Share of R&D scientists and engineers in chemical firms has declined since 1983

% of total industrial R&D scientists and engineers in the chemicals and allied products industry[a]



a Full-time equivalent, as of January of each year.
Source: National Science Foundation

R&D support expands more rapidly

CHARACTER OF UNIVERSITY R&D SPENDING: Two thirds of total is for basic studies

$ Millions	1985[a]	1984	1983	1982	1981	1980	1979	1978[b]	1977	1976	1975	Annual change 1984–85	Annual change 1975–85
Basic research	$6350	$5622	$5239	$4867	$4576	$4026	$3612	$3176	$2800	$2549	$2410	13%	10%
Applied research	2600	2376	2105	2006	1866	1691	1465	1213	1067	1015	851	9	12
Development	550	475	437	415	377	343	284	236	200	164	148	16	14
TOTAL	$9500	$8473	$7781	$7288	$6819	$6060	$5361	$4625	$4067	$3729	$3409	12%	11%

a Estimated. b Estimated, based on data from Ph.D.-granting institutions only. Note: Data for institutional fiscal years. Source: National Science Foundation

SOURCE OF UNIVERSITY R&D FUNDS: Industry support is still small but growing most rapidly

$ Millions	1985[a]	1984	1983	1982	1981	1980	1979	1978[b]	1977	1976	1975	Annual change 1984–85	Annual change 1975–85
Federal government	$6050	$5387	$4956	$4752	$4562	$4094	$3595	$3059	$2726	$2512	$2288	12%	10%
Industry	550	456	378	334	291	235	193	170	139	123	113	21	17
Universities	2200	2000	1864	1702	1520	1323	1200	1037	868	810	749	10	11
Other sources	700	630	583	500	446	408	373	359	314	284	259	11	10
TOTAL	$9500	$8473	$7781	$7288	$6819	$6060	$5361	$4625	$4067	$3729	$3409	12%	11%

a Estimated. b Estimated, based on data from Ph.D.-granting institutions only. Note: Data for institutional fiscal years. Source: National Science Foundation

FIELDS OF UNIVERSITY R&D SPENDING: 4% of total funds goes to chemistry

$ Millions	1985[a]	1984	1983	1982	1981	1980	1979	1978[b]	1977	1976	1975	Annual change 1984–85	Annual change 1975–85
Physical sciences	$1130	$ 994.8	$ 898.8	$ 826.1	$ 766.3	$ 677.4	$ 601.9	$ 496.4	$ 423.5	$ 379.4	$ 350.3	14%	12%
Chemistry	420	370.1	335.6	309.9	285.1	244.0	206.4	183.1	159.4	140.1	120.7	13	13
Physics	540	469.7	414.3	366.5	357.2	322.2	292.0	235.1	201.7	183.1	173.5	15	12
Engineering	1350	1202.6	1109.4	1029.4	961.0	864.9	768.4	601.1	498.5	431.7	380.9	12	13
Chemical	105	95.9	90.6	83.8	83.2	67.6	na	na	na	na	na	9	na
Total R&D spending	$9500	$8472.7	$7781.5	$7287.6	$6818.6	$6060.3	$5361.4	$4624.7	$4067.0	$3729.0	$3408.7	12%	11%

a C&EN estimates. b NSF estimates, based on data from Ph.D.-granting institutions only. na = not available. Note: Data for institutional fiscal years. Source: National Science Foundation

FEDERALLY FINANCED R&D SPENDING AT UNIVERSITIES: Increase last year best since 1980

$ Millions	1985[a]	1984	1983	1982	1981	1980	1979	1978[b]	1977	1976	1975	Annual change 1984–85	Annual change 1975–85
Physical sciences	$ 880	$ 779.1	$ 698.4	$ 650.0	$ 619.0	$ 554.8	$ 490.7	$ 392.3	$ 338.8	$ 305.4	$ 285.0	13%	12%
Chemistry	315	279.0	248.5	231.1	216.8	189.4	156.5	138.0	121.5	107.9	92.7	13	13
Physics	440	387.5	340.0	306.2	308.7	279.9	252.5	199.2	171.9	156.1	149.9	14	11
Engineering	880	778.7	737.6	698.2	682.5	595.4	526.4	407.5	336.7	280.5	238.4	13	13
Chemical	60	54.4	52.1	49.6	55.2	46.1	na	na	na	na	na	10	na
Total R&D spending	$6050	$5386.6	$4956.1	$4752.2	$4561.8	$4096.0	$3595.3	$3058.7	$2726.1	$2511.9	$2288.1	12%	10%

a C&EN estimates. b NSF estimates, based on data from Ph.D.-granting institutions only. na = not available. Note: Data for institutional fiscal years. Source: National Science Foundation

TOP 12 UNIVERSITIES IN R&D SPENDING: Johns Hopkins, MIT spend most on physical science

$ Millions, fiscal 1984	Physical sciences	Chemistry[a]	Engineering	Environmental sciences	Life sciences	Math and computer sciences	Other sciences[b]	Total
Johns Hopkins U	$56.9	$ 4.0	$108.2	$30.1	$ 81.9	$61.1	$12.7	$350.9
Massachusetts Inst. of Technology	63.6	11.7	90.3	12.0	31.1	12.5	12.6	222.1
U of Wisconsin, Madison	19.3	6.1	19.7	14.5	103.6	7.4	19.7	184.2
Stanford U	27.5	6.8	50.3	3.0	75.4	13.4	5.0	174.7
Cornell U	27.1	6.7	27.3	4.5	97.5	3.5	9.5	169.5
U of Minnesota	9.0	4.1	15.9	3.4	120.6	2.8	6.5	158.2
U of Michigan	10.9	2.8	19.9	8.5	74.9	3.5	38.3	156.0
U of Washington	8.2	2.3	10.1	14.2	91.8	3.0	19.7	146.9
U of California, San Diego	18.9	4.4	1.4	64.4	49.7	2.8	3.7	141.0
U of California, Berkeley	25.4	7.9	29.2	2.1	56.5	3.3	17.4	133.8
U of California, Los Angeles	14.7	7.2	16.4	8.1	80.8	1.2	10.9	132.1
Columbia U, main division	12.6	4.7	7.6	23.0	71.8	2.8	6.6	124.3

a Included in physical sciences. b Includes social sciences, psychology, and other sciences not listed separately. Source: National Science Foundation

TOP 12 UNIVERSITIES R&D CENTERS: Physical sciences get most funds

$ Millions, fiscal 1984	Physical sciences	Engineering	Environmental sciences	Math and computer sciences	Total[a]
Lawrence Livermore National Lab	$203.3	$378.0	$23.8	$82.5	$707.2
Los Alamos National Lab	301.0	201.3	14.9	53.9	619.3
Jet Propulsion Lab	86.3	209.5	46.0	179.8	521.5
Lincoln Lab	45.7	169.3	0	25.3[b]	240.5
Argonne National Lab	61.3[b]	105.5[b]	27.1[b]	2.9[b]	209.1[b]
Brookhaven National Lab	128.2	28.2	9.4	0.6	191.6
Fermi National Accelerator Lab	143.7	0	0	0	143.7
Plasma Physics Lab	138.8	0	0	0	138.8
Lawrence Berkeley Lab	78.7[b]	12.5[b]	13.4[b]	4.2[b]	132.7[b]
Stanford Linear Accelerator Center	74.5	0	0	0	74.5
National Center for Atmospheric Research	4.2	0	38.4[b]	0	42.7[b]
National Optical Astronomy Observatory	24.9	0	0	0	24.9

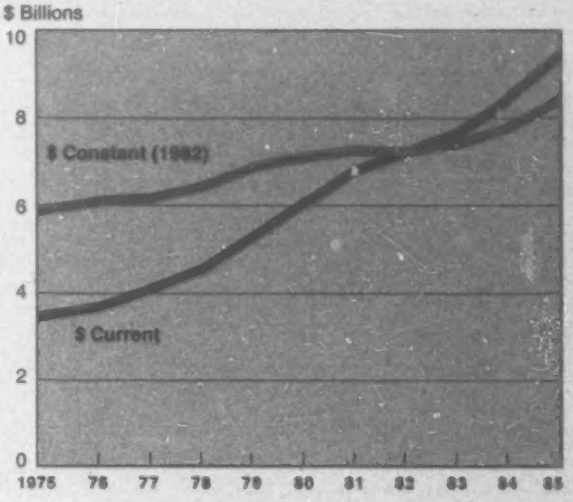
a Includes life sciences and other sciences not listed separately. b Estimated. Note: Data for university-administered federally funded R&D centers. Source: National Science Foundation

ACADEMIC SCIENTISTS AND ENGINEERS: Chemists account for 5% of total

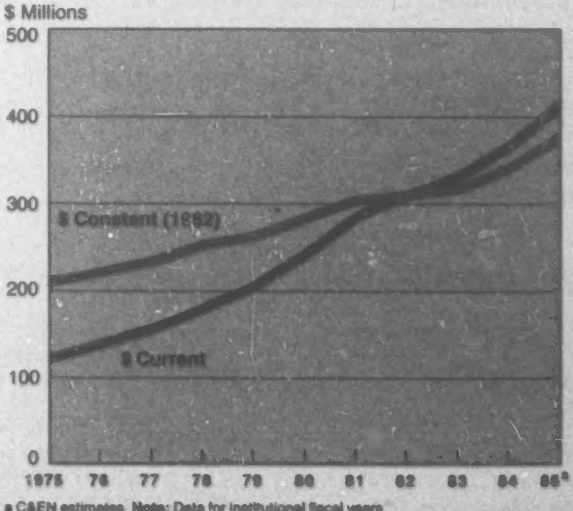
Thousands of scientists and engineers[a]	1985	1984	1983	1982	1981	1980	1978
TOTAL							
Physical scientists	36.5	35.9	34.8	34.5	34.1	33.6	32.8
Chemists	19.1	18.8	18.3	18.1	18.1	17.6	17.7
Physicists	14.1	13.9	13.6	13.3	12.9	13.0	12.8
Engineers	39.9	38.7	37.7	36.4	34.9	33.7	31.0
Chemical	2.6	2.5	2.4	2.3	2.3	2.4	2.0
Other scientists	304.0	295.9	286.4	278.2	265.6	256.9	243.9
TOTAL	380.4	370.5	358.9	349.1	334.6	324.2	307.8
FULL TIME ONLY							
Physical scientists	29.5	29.3	28.5	28.6	28.2	28.0	27.9
Chemists	15.1	15.1	14.8	14.7	14.8	14.3	14.7
Physicists	11.9	11.8	11.4	11.4	11.0	11.3	11.3
Engineers	30.1	29.3	28.8	28.0	27.0	26.5	24.7
Chemical	2.2	2.0	2.0	1.9	1.9	1.9	1.7
Other scientists	228.0	222.0	216.8	212.0	204.5	200.5	189.6
TOTAL	287.6	280.6	274.1	268.6	259.7	255.0	242.2

a In January. Note: Data not available for 1979. Source: National Science Foundation

Total spending for academic R&D, in real terms, gets a boost as inflation slows . . .



. . . and funding for academic chemistry also scores best recent real growth



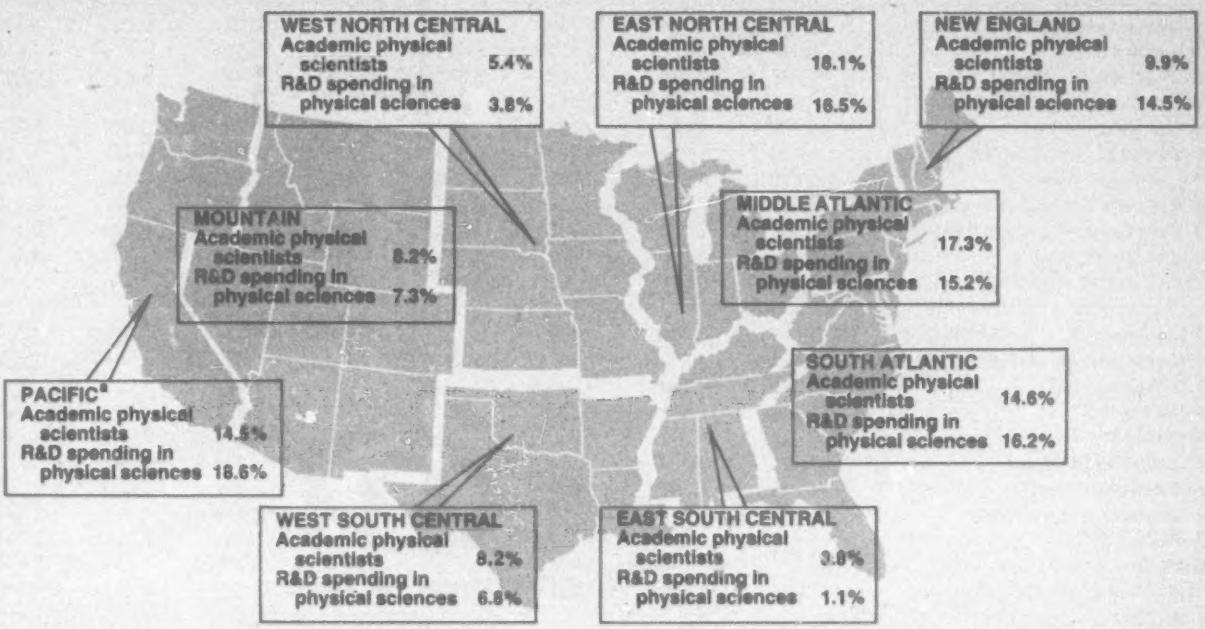
a C&EN estimates. Note: Data for institutional fiscal years. Source: National Science Foundation

SCHOOLS SPENDING MOST ON CHEMICAL R&D: 20% of total goes to top 10 institutions

$ Thousands	Total spending				Federally financed spending			
	1984	1983	1982	1981	1984	1983	1982	1981
1 Massachusetts Inst. of Technology	$ 11,741	$ 8,914	$ 9,792	$ 8,222	$ 11,055	$ 8,374	$ 9,096	$ 7,572
2 Harvard U	8,327[a]	6,898[a]	5,512[a]	6,123[a]	6,307	5,224	4,174	4,637
3 U of California, Berkeley	7,850	7,945	6,283	6,553	7,263	7,467	5,691	6,008
4 U of California, Los Angeles	7,219	5,496	5,187	4,420	6,389	5,047	4,978	4,127
5 Stanford U	6,809	6,589	6,634	5,564	6,120	5,068	5,893	5,337
6 Cornell U	6,710	5,717[a]	6,239[a]	4,618	5,775	4,766	5,437	4,062
7 U of Texas, Austin	6,639	5,938	4,843	4,779	3,873	3,527	2,781	3,017
8 California Inst. of Technology	6,446	6,994	6,136	6,901	5,810	6,554	5,809	6,196[a]
9 U of Maryland, College Park	6,324	6,333[a]	4,718[a]	3,109	2,862	2,834	3,068	2,418
10 U of Illinois, Urbana	6,284	5,886	6,422	5,239	5,005	4,668	4,763	3,847
Total, first 10 institutions	74,349	66,710	61,766	55,528	60,459	54,429	51,690	47,221
11 U of Massachusetts, Amherst	6,137	5,162	4,364	3,230	3,784	3,336	2,773	2,067
12 U of Wisconsin, Madison	6,076	5,310	4,567	4,122	4,391	3,693	3,404	3,134
13 U of Chicago	5,735	4,798[a]	4,396[a]	4,139[a]	5,116	3,998	3,716	3,719
14 Indiana U	5,642	5,551	5,341	3,637	4,694	4,642	4,237	3,042
15 Purdue U	5,443	4,542	4,459	4,600	4,452	3,966	3,946	3,715
16 Pennsylvania State U	5,124	4,729	3,564	3,413	4,564	4,236	3,222	2,773
17 U of Notre Dame	4,760	4,022	4,020	3,855	4,416	3,667	3,866	3,738
18 Columbia U, main division	4,662	4,281	4,700	3,564	4,639	4,279	4,365	3,471
19 Texas A&M U	4,610	4,963	4,521	4,069	2,735	3,327	2,823	2,793
20 Northwestern U	4,557	3,413	3,026	2,995	3,471	3,012	2,711	2,813
Total, first 20 institutions	127,095	113,481	104,724	93,152	102,721	92,785	86,753	78,486
21 U of Pennsylvania	4,375	4,982	3,068	3,386	3,921	4,037	2,745	3,073
22 U of California, San Diego	4,355	3,910	3,894	4,430	3,780	3,490	3,506	3,933
23 U of Oregon, main campus	4,255	3,351	2,971	1,389	3,524	2,686	2,530	1,235
24 U of Connecticut	4,135	2,720	2,049	1,748	2,753	1,445	1,113	1,022
25 Yale U	4,134	3,341	2,875	2,781	3,528	3,008	2,599	2,609[a]
26 U of Colorado	4,134	3,302	3,492	4,047	3,358	2,695	2,755	3,146
27 Ohio State U	4,104	3,616[a]	2,907	3,227	2,904	2,786[a]	2,355	2,679
28 U of Minnesota	4,067	4,047	4,297	4,260	3,346	3,345	3,377	3,494
29 Johns Hopkins U	4,030	4,592[a]	4,721	4,066	3,783	3,604[a]	3,800	3,881
30 U of Florida	4,024	2,347	2,248	2,302	2,042	1,325	1,341	1,156
Total, first 30 institutions	168,708	149,689	137,246	124,788	135,660	121,206	112,874	104,714
31 U of Pittsburgh	3,965	3,267	2,714	2,039	3,343	2,833	2,188	1,561
32 U of Rochester	3,658	3,167	3,123	2,966	3,490	2,800	2,774	2,553
33 Georgia Inst. of Technology	3,846	3,401	3,327	3,660	2,227	2,032	1,800	2,030
34 U of Utah	3,830	3,638	3,364	3,076	3,380	3,085	2,858	2,720
35 Howard U	3,672	2,336	982	1,406	3,300	2,069	867	1,248
36 Princeton U	3,670	3,509	3,062	2,513	2,892	2,642	2,485	2,142
37 U of South Carolina	3,423	2,721	2,483	1,087[b]	2,533	2,221	1,865	902[b]
38 Lehigh U	3,361	3,664	2,584	1,680	1,372	1,498	1,189	1,063
39 State U of New York, Stony Brook	3,084	2,607	2,783	2,691	2,156	1,809	1,901	2,080
40 Wayne State U	3,071	2,645	2,656	2,261	2,104	1,813	1,799	1,636
Total, first 40 institutions	204,488	180,644	164,324	148,167	162,457	144,006	132,600	122,566
41 U of North Carolina, Chapel Hill	2,945	2,397	2,240	2,016	2,699	2,381	2,218	1,936
42 U of Southern California	2,929	3,404	2,401	2,345	2,495	2,456	1,717	1,639
43 Arizona State U	2,875	3,062	2,323	2,153	2,014	2,124	1,996	1,958
44 Michigan State U	2,869[b]	2,714	2,493	2,178	2,044[b]	1,995	1,832	1,541
45 U of Michigan	2,786	2,244	2,064	2,016	2,356	1,853	1,547	1,591
46 Case Western Reserve U	2,759	2,232	2,185	2,139	1,904	1,443	1,487	1,732
47 Florida State U	2,740	2,500	2,959	3,012	1,140	1,115	1,124	1,463
48 Colorado State U	2,688	2,478	2,479	2,385	2,426	2,055	2,230	2,079
49 U of Oklahoma	2,676	2,890	2,306	1,399	1,150	1,453	1,067	674
50 U of Nebraska, Lincoln	2,549	3,431[a]	3,217	2,175	1,920	1,995[a]	1,995	1,757
Total, first 50 institutions	$232,304	$207,996	$188,991	$169,985	$182,605	$162,878	$149,813	$139,039
NATIONAL TOTAL	$370,123	$335,627	$309,889	$285,061	$279,035	$248,470	$231,108	$216,783

a Estimated. b Inferred. Note: Data for institutional fiscal years. Source: National Science Foundation

Schools east of the Mississippi account for close to two thirds of academic physical scientists and academic R&D spending in the physical sciences


WEST NORTH CENTRAL
Academic physical scientists 5.4%
R&D spending in physical sciences 3.8%
EAST NORTH CENTRAL
Academic physical scientists 18.1%
R&D spending in physical sciences 16.5%
NEW ENGLAND
Academic physical scientists 9.9%
R&D spending in physical sciences 14.5%
MOUNTAIN
Academic physical scientists 8.2%
R&D spending in physical sciences 7.3%
MIDDLE ATLANTIC
Academic physical scientists 17.3%
R&D spending in physical sciences 15.2%
SOUTH ATLANTIC
Academic physical scientists 14.6%
R&D spending in physical sciences 16.2%
PACIFIC[a]
Academic physical scientists 14.5%
R&D spending in physical sciences 18.6%
WEST SOUTH CENTRAL
Academic physical scientists 8.2%
R&D spending in physical sciences 6.8%
EAST SOUTH CENTRAL
Academic physical scientists 3.8%
R&D spending in physical sciences 1.1%

Key to map: Using the Middle Atlantic states as an example, 17.3% of all physical scientists employed at Ph.D.-granting universities and colleges in the U.S. are located in this geographical area and 15.2% of all R&D expenditures in the physical sciences by all Ph.D.-granting universities and colleges are made in this area. a Includes Alaska, Hawaii, and outlying areas. **Note:** Data are based on 20,699 physical scientists employed at Ph.D.-granting universities and colleges in the U.S. as of January 1985 and R&D expenditures of $972.9 million in the physical sciences during the 1984 fiscal year of all universities and colleges. **Source:** National Science Foundation

CHEMICAL DEGREES: Chem engineering graduate numbers continue to increase

Academic year	Degrees awarded in chemistry[a]			Degrees awarded in chemical engineering		
	Bachelors	Masters	Ph.D.s	Bachelors	Masters	Ph.D.s
1965–66	9,735	1839	1571	2848	994	354
1966–67	9,872	1831	1744	2869	949	305
1967–68	10,847	2014	1757	3211	1156	367
1968–69	11,807	2070	1941	3557	1136	409
1969–70	11,617	2146	2208	3720	1045	438
1970–71	11,183	2284	2160	3615	1100	406
1971–72	10,721	2259	1971	3663	1154	394
1972–73	10,226	2230	1882	3636	1051	397
1973–74	10,525	2138	1828	3454	1045	400
1974–75	10,649	2006	1824	3142	990	346
1975–76	11,107	1796	1623	3203	1031	308
1976–77	11,322	1775	1571	3581	1066	291
1977–78	11,474	1892	1525	4615	1237	259
1978–79	11,643	1765	1518	5655	1149	304
1979–80	11,446	1733	1551	6383	1271	284
1980–81	11,347	1654	1622	6527	1267	300
1981–82	11,062	1751	1722	6740	1285	311
1982–83	10,746	1604	1746	7145	1304	319
1983–84	10,704	1667	1774	7475	1514	330

a Data do not include biochemistry and geochemistry. **Source:** Department of Education's National Center for Education Statistics

GRADUATE SCIENCE STUDENTS: 6% are majoring in chemistry or biochemistry

Thousands	1984	1983	1982	1981	1980	1979	1978
TOTAL							
Physical sciences	**28.4**	**27.7**	**26.5**	**25.8**	**25.4**	**24.9**	**24.7**
Chemistry	16.6	16.5	15.8	15.2	15.1	14.9	14.8
Physics	11.0	10.5	10.0	9.9	9.6	9.3	9.2
Engineering	**88.2**	**86.0**	**78.2**	**74.4**	**70.1**	**67.2**	**64.3**
Chemical	7.2	7.4	6.9	6.3	5.9	5.4	5.2
Metallurgical and materials	3.6	3.3	3.0	3.0	2.8	2.7	2.5
Petroleum	0.7	0.7	0.6	0.5	0.5	0.4	0.4
Life sciences	**92.6**	**91.2**	**90.7**	**90.9**	**90.7**	**87.5**	**85.9**
Biochemistry	4.5	4.2	4.1	4.0	4.0	3.9	4.0
Other sciences[a]	**154.3**	**153.3**	**151.4**	**148.9**	**147.5**	**141.0**	**134.9**
TOTAL	**363.5**	**358.2**	**346.8**	**340.0**	**333.7**	**320.6**	**308.8**
FULL TIME ONLY							
Physical sciences	**25.1**	**24.5**	**23.3**	**22.6**	**22.3**	**21.8**	**21.5**
Chemistry	14.6	14.5	13.7	13.2	13.1	12.8	12.7
Physics	9.8	9.4	8.9	8.8	8.5	8.3	8.2
Engineering	**54.8**	**53.5**	**48.7**	**44.8**	**41.9**	**39.3**	**37.1**
Chemical	5.7	5.8	5.5	4.9	4.4	4.2	3.9
Metallurgical and materials	2.9	2.7	2.5	2.4	2.2	2.1	2.0
Petroleum	0.6	0.6	0.5	0.4	0.4	0.3	0.3
Life sciences	**66.2**	**65.2**	**65.7**	**67.2**	**67.7**	**66.5**	**65.2**
Biochemistry	4.3	4.0	3.8	3.7	3.7	3.6	3.7
Other sciences[a]	**100.7**	**100.4**	**99.2**	**99.6**	**98.6**	**95.8**	**92.8**
TOTAL	**246.8**	**243.8**	**236.9**	**234.2**	**230.5**	**223.4**	**216.6**

a Includes environmental, mathematical, computer, and social sciences and psychology. **Note:** Data for Ph.D.-granting institutions only. **Source:** National Science Foundation